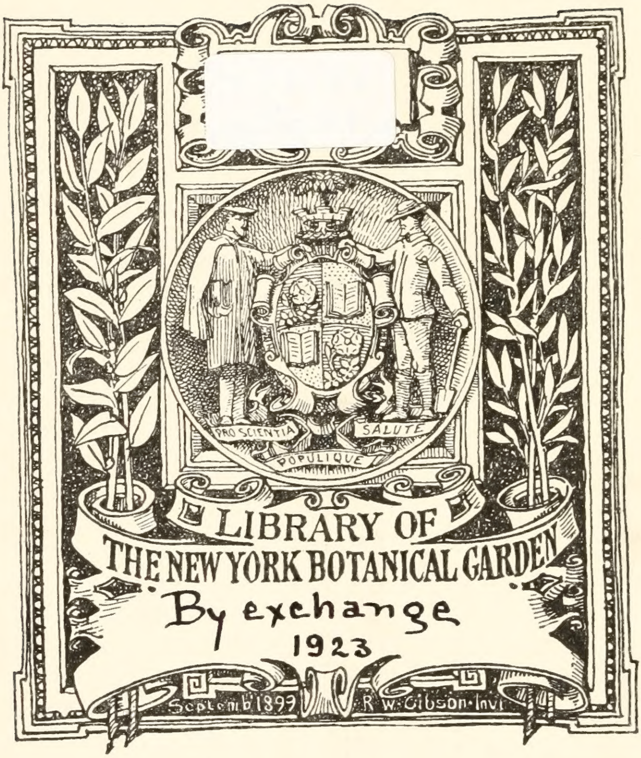

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ANNUAL REPORT OF

# THE DEPARTMENT OF AGRICULTURE

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## ANNUAL REPORTS OF

# THE DEPARTMENT OF AGRICULTURE

FOR THE YEAR
ENDED JUNE 30
1922

## REPORT OF THE SECRETARY OF AGRICULTURE

## REPORTS OF CHIEFS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

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1922

[CHAPTER 23, Stat. L., 1895.]

[AN ACT Providing for the public printing and binding and the distribution of public documents.]

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Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

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# REPORT OF THE
# SECRETARY OF AGRICULTURE.

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# REPORT OF THE SECRETARY OF AGRICULTURE.

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WASHINGTON, D. C., *November 15, 1922.*

To the PRESIDENT;

If financial rewards were measured out in proportion to the results of honest, productive effort (unfortunately they are not always), the farmers of the Nation would have little reason to complain of their returns this year. In contrast with various other groups of workers they have produced abundantly and without cessation. This year the acreage of the 14 principal crops is about 337,000,000 acres, which is 7,000,000 acres above the 10-year average, and but 1,000,000 acres below last year. Production of these 14 crops is estimated for this year to be a total of about 265,000,000 tons, which is 11,000,000 tons above last year and above the 10-year average. This great total is the result of long hours of hard work, aided by favorable weather conditions. If the relationship between prices now was such as existed before the war, this would be a prosperous year for agriculture, and consequently a prosperous year for the Nation. With the distorted relationship of prices at the present time, the farmers, notwithstanding their hard work and large production, find themselves still laboring under a terrible disadvantage as compared with other groups. There is food in superabundance, and this contributes to the prosperity of business and industry for a time, but the inadequate return which the farmer is receiving, and has received for three years, inevitably must result in readjustments in the number of people on the farms and in the cities, which will not be for the continuing good of the Nation.

In my report last year I dealt at some length with the unfavorable economic conditions affecting our agriculture, and pointed out particularly the greatly reduced purchasing power of the farmers, who comprise about one-third of our population, caused by the decline of prices of farm products to below the pre-war level, while prices of most other things remained from 50 to 100 per cent above the prewar level. Much of what was said in my report at that time applies

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to conditions now existing. There has been some increase in prices of farm products, but there has not been much improvement in the general relationship between the prices of the things the farmer produces and of the things he buys.

Harvest time last year found most agricultural products selling at bankruptcy levels. During the early spring of this year the farmer's condition was improved by substantial increases in the prices of many farm products, although this improvement did not inure to the benefit of the farmer as much as it should, since the major portion of his products had passed out of his own hands. Of the 12 representative farm products—cotton, corn, wheat, hay, potatoes, beef cattle, hogs, eggs, butter, tobacco, sheep, and wool—7, cotton, corn, cattle, hogs, tobacco, sheep, and wool, show advances in prices this year as compared with the same month last year. The other 5 were selling in September at prices lower than the prices in September, 1921. If we take all farm products and express prices in terms of index numbers, we find that the index for August, 1922, stood at 123 as compared with 122 for the year 1921.

The index number varies somewhat with different regions. Roughly speaking, it is lower from Ohio east, about the same in the Middle Western States, lower in the Northwest, and considerably higher in the Southern States, the latter being due to the very substantial advance in the price of cotton.

While the prices of many important farm products have advanced considerably over last year, this advance has been accompanied by equally large or larger advances in the price of other commodities. For example, the index of wholesale prices of commodities other than farm products was 176 in August of this year as against 150 in August, 1921. For a time last spring farm prices had advanced more relatively than prices of other things. This advance was not fully held, as was to be hoped for. The index of purchasing power at the present time is about what it was in December, 1921, which was at the lowest point since the war. In August and September, 1922, a given unit of farm products could be exchanged for only about two-thirds (64 per cent) as much of other commodities as that same unit would have purchased in the year 1913. At the time this report is submitted an encouraging advance in farm prices is being registered and the future looks decidedly more hopeful.

## LOW PRICE FOR FARM PRODUCTS—HIGH PRICES FOR OTHER COMMODITIES.

Among the causes which contribute to the abnormal relationship of farm prices to the prices of other things may be mentioned:

Overproduction of many farm crops.

Continued high freight rates.

The maintenance of industrial wages at near war-time levels.

Economic depression and depreciated currency in European countries.

Interference with the efficient functioning of necessary industries.

Unreasonably high costs of distribution of some farm products.

Some contend that there is no such thing as overproduction of farm products and can not be as long as there are people in the world who suffer for food and clothing. On the same line of reasoning it can be argued that the production of automobiles will be inadequate until every man and woman and every boy and girl of high-school age owns one. There is overproduction, so far as the producer is concerned, whenever the quantity produced can not be marketed at a price which will cover all production costs and leave the producer enough to tempt him to continue production. And whenever there is such overproduction the output will be reduced either by conscious effort on the part of the producers or by the operation of economic laws which drive the less efficient producers out of the business. The fact is that for three years in succession the farmers of the United States have produced more of some crops than could be sold at prices high enough to cover production costs.

It will never be possible for the farmers to relate their production to profitable demand with the nicety of the manufacturer, both because they can not control the elements which influence production and can not estimate demand as closely. Neither will the farmers ever be able to organize as have the labor unions, and by rules and regulations and disciplinary measures compel obedience to policies adopted. They can, however, bring about a better adjustment of production, and especially of marketing, to the needs and purchasing ability of possible customers, if they will perfect their organizations and call to their aid men skilled in interpreting conditions which influence supply and demand. Better adjustment of farm production is worth striving for. Both the farmers and the consuming public would be benefited through more stable production and therefore more stable prices.

There were substantial reductions in freight rates on farm products during the year, but rates still remain far above pre-war levels and constitute a heavy burden on agriculture. In the case of some crops grown at considerable distance from the large consuming centers freight rates are now prohibitive or so nearly so as to make crop readjustments imperative. If this condition should continue industrial readjustments must follow, our manufacturing centers gradually being shifted westward toward the great agricultural surplus-producing regions. In the case of some crops, notably fruits and vegetables, the higher freight rates tend to benefit eastern farmers at the expense of western and southern. In the case of the coarse grains and hay, however, the finished product of the western farmer is to some extent the raw material of the eastern farmer and the advance in freight rates hurts both.

The cost of labor is one of the largest elements which determine the price the farmer must pay for what he buys, whether it be transportation, fuel, implements and machinery, clothing, or what not. The success of industrial labor in holding most of the gains in wages secured during the war period and the two years following accounts for a considerable part of the higher prices the farmer is now paying for what he buys. Wages of men working in organized industries, including transportation, remain at 50 to 100 per cent above pre-war levels and are perhaps within 10 per cent of the high level of 1920. These wages are carried into the price of the things produced. The farmer's income on the other hand is down to or below the pre-war level. The farmer benefits when there is full employment for labor and when wages are good, because the wage workers can then buy freely of farm products. There is a limit, however, beyond which consumption is not increased, and as wages advance beyond this point they add to the cost of the things the farmer must buy and thus increase his own cost of production without in any way enlarging the market for what he produces.

The depreciation in the currency of European countries and the general economic depression existing there tends to narrow the outlet for our surplus crops. During 1921 we exported large quantities of agricultural products, especially those products which were selling at ruinously low prices. This export movement has been decreasing. European agriculture is gradually being restored and necessity requires restricted buying by the consuming public. Another phase of this export movement is the postponement of European buying. In times past the tendency was to come into our markets promptly and lay up farm products in store. Now the tendency overseas is to use up all available domestic supplies and import as little as possible. This requires us to hold our own exportable crops longer than before and adds to our credit and storage difficulties. The condition of our agriculture would seem to justify a thorough study of the international situation as it bears upon the outlet for the products of our farms.

Conflicts between employers and employed in necessary industries directly injure the farmer in many ways. When men are out of work food consumption is necessarily reduced, notwithstanding strike benefits paid. When the dispute affects transportation, the movement of farm products is seriously interfered with. During the recent railroad strike, for example, many fruit and truck farmers were unable to move their perishable products, and as a consequence suffered very heavy losses, running into many millions of dollars. Delays in transportation cause heavy shrinkage in live stock moving to market, as well as damage to many other farm products resulting from deterioration because of delayed movement. As a result consumers in the cities are compelled to pay unreasonably high prices, while producers on the farms must take lower prices. The effect of the transportation strike will injuriously affect the farmers long after the men are back at work, because of the impaired condition of the equipment. So also farmers suffered severely from the coal strike. In many sections thrashing was delayed, at heavy loss through exposure of the grain to the weather. Farmers were compelled to pay exorbitant prices for such coal as they were able to buy, and the necessity of moving coal when finally the mines and the railroads resumed operations interfered materially with the prompt movement of farm products.

Cost of distribution of farm products remains high, notwithstanding frequent violent denunciations of profiteers in the cities. In part, this high cost of distribution is caused by the multiplication of distributing agencies during the past six years, in part by the increase in rent, wrapping paper and containers, twine, ice, etc., but in larger part by the higher wages which employees in the distributing business have been able to maintain.

Although not directly affecting the price of farm products, the tremendous increase in taxes has added a burden which is very heavy to carry. In most farming States taxes on farms have more than doubled. On 155 farms in Ohio, Indiana, and Wisconsin in 1913 the income available for the owner's labor, profit, interest on capital, and taxes—that is, receipts less expenses other than taxes—averaged $1,147 per farm. Taxes averaged $112 per farm, which amounted to 9.8 per cent of the foregoing income figure. On these same farms in 1921 the estimated income available for labor, profit, interest on capital, and taxes averaged $771 per farm. The taxes in this year were $253 per farm. Taxes, in other words, absorbed one-third of the farm income in 1921, as compared with less than one-tenth in 1913. Between 80 and 90 per cent (the percentage varying in different sections) of the taxes paid by the farmer is for expense within the county, the larger items being schools and roads. Such taxes, therefore, are within the control of the majority of the people in the county. Nevertheless, the increase in taxes is proving to be one of the most frequent subjects of complaint by farmers, as answers to a questionnaire sent out by this department showed very clearly, and during the next few years the whole question of taxation will evidently receive considerable attention by thoughtful farmers.

### HOW THE FARMERS ARE WEATHERING THE STORM.

The production records of this year furnish a vivid illustration of the vitality of American agriculture and of the courage and hopefulness of the American farmer. Certainly no other industry could have taken the losses agriculture has taken and maintain production, and we have no evidence to show that any other group of workers would have taken the reduction in wages in the spirit in which the farmers have taken their reduction.

Many thousands of farmers have not been able to weather the storm, notwithstanding their most strenuous efforts. Thousands who purchased land during the period of high prices, making a small payment down, have been obliged to give up the struggle, let the land go back, lose all the money they paid for it, and start anew. Many thousands of renters who had substantial savings invested in farm equipment and live stock have gone through the same experience and have lost everything. A pathetic picture which illustrates this comes in a letter from a farmer in a western State. He writes:

"Our neighbor joining us on the east, a hard-working man, had rented 320 acres of land. He and his wife and one hired man farmed it. They had about 100 head of cattle and about the same number of hogs. The 1st of December they turned everything over to the landlord, save one team, which they hitched to an old wagon, put in their household goods, got in the wagon themselves, and drove away to town to get work at day labor and make a new start in life."

Most farmers have succeeded in maintaining themselves and their hold on the land by the exercise of the most rigid economy. They have refrained from buying anything they could possibly get along without. This enforced economy has contributed very much to the difficulties of manufacturers, dealers, and retailers, who are largely dependent upon farmers for their customers. Manufacturers of farm implements and machinery especially have suffered, farm purchases of such having decreased enormously since the summer of 1920. The result of this has been a steady depreciation in farm equipment.

Labor cost of production has been greatly reduced, both by lower wages paid farm hands and the reduction in the amount of labor employed. In the case of farm wages, in 1922 they were but 36 per cent above the 1913 level, having declined 38 per cent of the high level of 1920. Perhaps the larger reduction in labor cost of production, however, has come through longer hours and harder work by the farmer, the farmer's wife, and the farmer's children. To some extent the work of the children has been at the expense of their education, a matter in which the entire Nation may well feel concerned.

In addition to rigid economy in the purchase of such things as implements, machinery, and in the making of needed improvements, apparently there has been a much to be regretted reduction in the farmer's standard of living. It is not possible to measure this with any degree of accuracy, but our reports show that for the year ending August 1, 1922, there were slaughtered on the farms 10 per cent fewer hogs than in the year 1921 and 20 per cent fewer than in the year 1920.

With a view to reducing market costs there has been a very large increase in the number of cooperative marketing associations, large and small. Such associations, when well conducted, effect considerable savings in marketing costs. In addition, they are decidedly helpful in indirect ways, such, for example, as directing attention to the grading of farm products and prices as influenced by grades, to the need of regulating the amount marketed to what the demands of the consumers will absorb at a fair price, and in general to the economics of agriculture. Soundly organized cooperative associations are now able to command the credit needed to enable them to market crops in a more orderly fashion. As sound principles of cooperative marketing become better understood and applied, the benefit growing out of such associations will correspondingly increase. The department is gathering information on successful cooperative methods at home and abroad.

The need of better quality in both crops and live stock is more and more coming to be realized. This is indicated by the increase in the number of pure-bred sires and the organized movement in many sections of the country to replace inferior stock with better.

### HOPEFUL ASPECTS.

Notwithstanding the continued low purchasing power of farm products, it is fair to say that in general the farmers of the United States are in a better position financially now than they were a year or 18 months ago. Farm products are selling at considerably higher prices, and it is estimated that the aggregate value of the crops in the country this year is about a billion and a quarter dollars more than last year. Considerable quantities of these crops will be fed and the increased value will not be wholly recovered to the farmer, but the bare fact that such a large increase in money will reach the farmers' pockets this year is most gratifying and reassuring.

The advance in price of cotton has been most helpful throughout the cotton-producing States. While the crop is short in many areas, the cotton-growing country as a whole is probably in better condition financially than it has been for three years.

Considerably higher prices for wool, lambs, and sheep have resulted in pulling the sheep industry out of a slough of despond and setting it on its feet again. This is especially helpful to the industry in the range country.

Right through the period of depression hogs have been selling at considerably higher prices relatively than corn. This has enabled farmers in the great corn-producing States to secure much higher prices for their corn by feeding it to hogs than they could get by selling it as corn. Thirty-five to forty per cent of our corn crop is fed to hogs. Hog prices continue relatively higher than corn. This is stimulating hog production and there is danger that it may be overdone another year.

On the whole it has been a fairly satisfactory year for cattle feeders, the prices for fat cattle holding gratifying levels. Growers of cattle in the range country, and especially those who have marketed inferior grades of cattle, have not been so fortunate.

Credit conditions have vastly improved. Interest rates have fallen as compared with a year and 18 months ago. The banks in the agricultural sections are in far better condition to serve their farmer customers and there seems reason to believe that this condition will continue to improve.

The greatly accelerated movement of farmers, and especially farmers' sons, from the farms to the cities and industrial centers is one of the hopeful signs. It is not possible to measure this movement with absolute accuracy, but our best estimates indicate that during the months of July, August, and September twice as many persons left the farms for the cities as normally. This movement is in direct response to the willingness of the buying public to pay much higher prices for labor in the building trades, manufactures, and industries than for labor on the farm. When fair relationships between agricultural and other prices are restored and the capable worker can market his labor on the farm, whether by working for himself or for another farmer at wages which will compare favorably, all things considered, with the wages he is able to get in the city, the movement will again become normal.

Another hopeful sign is the increasing willingness and desire of people engaged in industry, commerce, and finance to help bring about a more favorable adjustment for the farmer. Such people are coming to realize more and more the menace to themselves in conditions so unfavorable to agriculture as those of the past three years. Their attitude toward the farmer has changed from that of a benevolent paternalism such as was so much in evidence during the 10 years preceding the war. They now understand more clearly that their own future is inseparably linked up with the farmer, and that in doing what they can to help him get on his feet again they are helping themselves as well.

### HELPFUL LEGISLATION.

In my report of last year I called attention to certain legislation recently enacted by Congress which promised to be helpful in relieving the agricultural depression. This promise has been made good. The activities of the War Finance Corporation undoubtedly saved many thousands of farmers from bankruptcy and hundreds of banks in agricultural States from passing into the hands of receivers. The benefit came not alone from the more than $350,000,000 of new money which was made available for agricultural purposes, but from the renewed confidence which was inspired and the good effect upon interest rates charged by banks and other loan agencies. The measures which made possible greatly increased mortgage loans on the part of the farm land banks and joint-stock land banks contributed materially to relieving the financial stress by making it possible for thousands of farmers to refund their obligations and get them on a basis of deferred payments. These measures also were influential in reducing the rate of interest on mortgage loans.

The amendment to the Federal reserve act which provides that in making appointments on the Federal Reserve Board due regard shall be had to securing a fair representation of the agricultural, as well as the financial, industrial, and commercial interests, makes proper provision that the voice of agriculture shall be heard on this powerful credit agency when policies are being considered which may affect agricultural credit or agricultural prices.

The act to encourage the organization of farmers' cooperative marketing associations by giving them proper standing under the law, and thus assuring them from improper prosecution by overzealous officers, has made possible and stimulated greater activity in the organization of such associations.

The packers and stockyards act, which brings all packing houses, stockyards, and stockyard agencies under Government supervision, gives assurance that free, open, and competitive conditions will be maintained in the live-stock markets, and that farmers and stockmen will be protected against unfair and improper practices, as well as combinations which militate against them. More than this, this act gives opportunity for the first time to make a systematic study of the marketing of live stock from the time it leaves the farm until it reaches the wholesaler of meats in the city. Out of such study there should come in time more efficient methods of marketing, and especially more efficient methods of distribution.

The grain futures act, which extends Government supervision over the grain exchanges on which grain is bought and sold for future delivery, gives a similar opportunity to make a study of the present system of grain marketing. Up to the present time it has not been possible to secure that information, which must be had to form an intelligent idea of the effect of the dealings on these grain exchanges. If the act shall be held to be constitutional by the Supreme Court, that opportunity will be afforded.

The Joint Commission on Agricultural Inquiry, composed of members of the House and Senate, sat for many months during 1921, and the following winter made an extended report of its findings. This report contains a mass of material which will be exceedingly helpful in working out national policies designed to aid agriculture. It is the most comprehensive report on the subject which has ever been prepared.

Congress passed a number of other acts of lesser importance, but all helpful. No Congress in our history gave more extended, sympathetic, and understanding consideration to agriculture than the Congress which convened in March, 1921.

### THE NATIONAL AGRICULTURAL CONFERENCE.

In January, 1922, there was held in Washington a national agricultural conference, called at your request. This conference was attended by 336 delegates. Some 20 different national farm organizations sent delegates, representing all phases of agricultural activity, these delegates numbering 87 and coming from 37 different States. There were individual farmers in attendance to the number of 80, from 30 different States. There were 84 delegates officially connected with agricultural organizations of the different States. There were 67 delegates representing businesses having direct relation to agriculture, and there were 18 women delegates.

Following your splendid opening address, the delegates were assigned to various committees, and spent four days considering matters relating to agriculture. At the conclusion of the session the conference brought in a number of important recommendations, some of them suggesting legislation, some suggesting administrative action, and some suggesting certain matters which should have the attention of farmers and farm organizations. The details of the discussions and the recommendations were presented to you in a special report February 6, 1922. Favorable action has been taken on most of the more important recommendations of the conference. The presence of this large number of practical farmers from almost every State afforded an opportunity for conference between them and the workers of the Department of Agriculture, and this intimate contact with the delegates proved most helpful in stimulating department activities, especially along economic lines. The coming together of men of widely divergent views from so many different sections was most beneficial in every way.

### CREDIT LEGISLATION NEEDED.

Among the recommendations of the national agricultural conference were two which dealt with the matter of farm credit. One urged the increase of the maximum which may be loaned to an individual by the Federal farm land banks from $10,000 to $25,000. The other expressed the need for a better system of credit for production purposes. Neither of these recommendations have been acted upon as yet, although the need of favorable action is urgent.

In the more highly productive agricultural regions the amount required to be invested in the average-sized farm which is the most economical unit for the average farm family is so great that a mortgage loan limited to $10,000 is not large enough to meet the needs of the average farm owner. Many farmers are therefore deprived of the benefit of the Federal farm land bank system and just at a time when they most need it. This limit should by all means be increased to $25,000 as quickly as possible.

Short-time or working credit used by the farmer comes from two sources, the commercial banks and the merchants, the latter also necessarily being carried by the banks. The trouble with this short-time farm credit is that very often the notes given run for a shorter time than the farmer needs the money, and therefore must be renewed, and often the rates are higher than farm profits justify the farmer in paying. Our short-time credit system has been devised rather to meet the needs of business and commerce, both of which have a shorter turnover than agriculture. When business conditions are normal the farmer has gotten along fairly well. In times of stress the forms of short-time credit upon which he is obliged to rely often force him to sell his crops and live stock at severe sacrifice. There should be made available to agricultural producers a credit system adapted to their particular needs. Particularly there is needed a system of intermediate credit under which the farmer can borrow for periods of six months to three years. This form of credit is needed especially for live-stock production and feeding and for development purposes, such, for example, as the purchase of certain kinds of machinery, the building of silos and barns, the fencing and draining of land, etc. The need for credit of this sort has been recognized for a great many years. The lack of it made necessary the activities of the War Finance Corporation during the past year. Agriculture should not be required to depend on emergency organizations of this sort.

Congress has been giving consideration to this matter of intermediate credit. A number of bills have been before the appropriate committees for some months. It is very much to be desired that definite action be taken at the earliest possible moment.

## COMMODITY AND REGIONAL COUNCILS.

With the desire to be of the greatest possible service in the task of restoring agriculture to a prosperous basis we have been making comprehensive studies of the conditions which influence the profitable production of various crops, carrying on these studies through what we call commodity councils. These councils are composed of representatives of the various bureaus and suborganizations of the department which have anything to do with the crop being studied. The cotton council will serve as an illustration. Meetings of this council are attended by the people who understand the soils of the Cotton Belt, by those who have made a special study of varieties as adapted to certain soils, by the experts in cultural methods, by the entomologists who understand injurious insects, their habits and methods of combating them, by specialists who understand grading and marketing methods and the conditions which influence demand, both at home and abroad, and by many others who have information needed to help bring about the most economical production and marketing of cotton. It is expected that out of these deliberations by the cotton council will come certain definite department policies with regard to cotton. When such policies have been formulated it is expected that meetings will be held with agricultural agencies and cotton farmers in the various cotton-producing sections. These meetings should result in formulating policies best adapted to the profitable production and marketing of cotton in the various sections, and the various agencies interested will then undertake to bring these policies to the attention of cotton growers through the cooperative extension agencies of the department and the various States. The same general policy will be followed with regard to all the principal crops.

Out of the deliberations of these councils which deal with particular crops it is expected there will grow regional councils which will consider in the same thorough and comprehensive way the agriculture of important regions of the country. For example, in the spring-wheat region of the Northwest there are certain large agricultural problems peculiar to that region. The same is true of the winter-wheat region of the Southwest and Central West and of the Corn Belt region. The problems to be studied are not limited to the growing of particular crops, but embrace the marketing of those crops, the interchange of crops and commodities, and the relations between the agriculture and the industries of the various regions.

It seems perfectly clear that developments of the past five years, the important changes in freight rates on agricultural and industrial commodities, and the uncertainties of the foreign market will make necessary important readjustments in agricultural production and marketing. Through such studies as are being made in these commodity councils it is the hope of the Department of Agriculture to be helpful in making such readjustments.

## ECONOMIC RESEARCH WORK.

On July 1, 1922, the consolidation of the branches of the department doing economic research work was completed, the new bureau being known as the Bureau of Agricultural Economics. Included in this bureau are the former Bureau of Markets, the Bureau of Crop Estimates, and the Office of Farm Management and Farm Economics.

The merging of these three units into one had been anticipated by an informal reorganization of their work. It is now possible to make a comprehensive study of economic questions involved in production, marketing, and distribution of farm products, following every step of these processes. This is necessary to secure for farmers the information needed to put American agriculture upon a permanently productive and profitable basis. Studies are under way which will cover every process through which the more important products of agriculture pass on the way from the farm to the consumer.

An intensive study is being made of the part distributors play in financing the production of fruits and vegetables, and the effect on production, distribution, and price. Also, studies are being made of the organized fruit-auction companies in the larger city markets. It is estimated that these companies handle about $150,000,000 worth of fruit each year, but little is known of them and their manner of doing business. Studies are being also made to secure detailed information on such matters as production, supply, distribution, and consumption of fruit and truck crops.

### MARKETING OF LIVE STOCK AND MEATS.

Through cooperation with the buying and selling agencies at the Chicago market, live-stock marketing information is being gathered to show the State origin, number, and average weight of each grade of beef steers received, together with the average price paid and the final disposition. This information makes it possible to determine the seasonal supply of the various grades of steers arriving at Chicago and the number going to the country for further feeding or grazing. Information is also being gathered to ascertain the percentage of each market class of sheep and lambs in the total receipts at Chicago, and the average weight and price of these classes. Information of this sort is necessary as a basis for enabling producers and feeders both to plan their operations and to regulate the marketing of their stock, and becomes more and more valuable as it accumulates.

### COMPETITION AND DEMAND IN FOREIGN COUNTRIES.

As long as we export considerable quantities of wheat, cotton, pork, and other farm products, it is important that we be informed as to competition to be met in foreign markets and as to conditions which influence demand and price. During the past year the department has had representatives in Argentina and in the Balkan countries, both of which compete with us to some extent, and in England and some of the other countries which buy from us. In addition to maintaining these representatives, two specialists were sent to Europe to make an economic survey of agricultural reconstruction there and to arrange for the interchange of information as to production and demand in those countries.

### CROP AND LIVE-STOCK REPORTING SERVICE.

Plans have been made to greatly improve and broaden the statistical work of the department, especially as it relates to crop and live-stock production. A committee of experienced statisticians of national standing was called in and asked to consider carefully our statistical methods and make recommendations. This committee spent some time here and made recommendations of value, which are being adopted as rapidly as possible.

For many years the department's statistics on acreage and production of the principal farm crops have been regarded as very accurate. Live-stock statistics have not been so satisfactory, due in large part to inadequate funds. Congress gave larger appropriations for the current year, and in cooperation with leading live-stock producers a program has been worked out which should result in much more reliable and complete live-stock statistics in the future. This program provides for the elaboration of the annual estimates of numbers of live stock on farms to show age and sex; preliminary and final estimates yearly of the calf and lamb crops of the range States; periodical estimates of the supply and probable movement of feeder cattle, sheep, and lambs in the range States; periodical reports of the numbers of cattle, sheep, and lambs on feed for market; periodical surveys of special live-stock producing areas; reports of the seasonal movement of cattle, sheep, and lambs from the range to the feed lots and from feed lots to market; semiannual reports of the spring and fall pig crop, gathered through rural mail carriers and field representatives of the department; monthly reports of feed and pasture conditions. The Postmaster General has taken a personal interest in the success of these pig surveys made through the cooperation of his department, and they have been quite successful. The information with regard to the production and potential supply of hogs is very valuable, affecting as it does the market for and price of corn as well.

### COST OF MARKETING.

Cost studies in the field of marketing have been pursued in an effort to get at the actual costs of marketing farm crops by various methods. The services performed and their cost by each of the agencies in the marketing process are being studied. Particular attention during the past year has been given to the cost of marketing live stock in the Corn Belt States, the information in all cases having been secured from accounting records. Reports of these studies will be made public as they are completed.

### GRADES AND STANDARDS FOR FARM PRODUCTS.

The necessity for establishing grades and standards for farm products of all kinds becomes increasingly evident. Clearly defined and generally accepted grades not only prevent innumerable irritations, annoyances, and abuses, but help the farmer produce to better purpose and with fuller understanding of market needs. In the case of many farm products acceptable and fairly well understood grades already have been established, such, for example, as the grain and cotton grades. For some time studies have been in progress with the hope of perfecting market classes and grades for live stock and dressed meats. This work has been carried on in connection with the market-reporting service, the tentative grades being used as the basis for the market reports. Numerous conferences have been held with producers and members of the trade, and recommendations and suggestions have been invited, so that when standards are adopted they will be suited to trade conditions. Illustrated bulletins describing the various classes and grades and defining terms are now in course of preparation. Manuscript for a bulletin on "Market Classes and Grades of Dressed Beef" is in the hands of the printer. Similar bulletins will be submitted soon dealing with grades of cattle, hogs, veal, lamb and mutton, and pork carcasses, and cuts and miscellaneous meat products.

The standards for grade and color of American Upland cotton and for American-Egyptian cotton were revised during the year and a change was made in the grade names by the introduction of the numerical system to supplement the present grade names. The revised standards will become effective on August 1, 1923.

Much progress was made during the year in the wool standardization work. More than 500 sets of the tentative wool grades have been prepared and distributed among wool manufacturers, dealers, growers, agricultural colleges, and others interested, every State being represented. In this way interested people are able to study the grades until they come to know them.

Up to the present time grades have been formulated and recommended for 14 of the more important fruits and vegetables. These grades have been brought to the attention of growers and dealers through demonstration work done in cooperation with State representatives and with organizations of growers. Assistance also is given to States in preparing and revising grades for a large number of products.

Tentative standards have been prepared for eggs, and attention is being given to the preparation of standards for live and dressed poultry.

Tentative hay grades have been formulated for timothy, clover, timothy and clover mixed, mixed grass and timothy, and grass mixed hay. A complete exhibit of these grades has been prepared for display at conferences, conventions, terminal markets, and elsewhere. Also a bulletin on the subject "Laboratory Methods in Hay Standardization" is being prepared for early publication.

### REVISION OF GRAIN STANDARDS.

Complaint of the wheat grades, especially in the Northwest, led to a very thorough study of these grades during the summer and fall of 1921. Experts not connected with the department were employed to make a full investigation in the field. Many conferences were held with the trade and inspection departments, as well as with producers. As a result of these investigations some slight changes were made in the wheat and corn grades, and important changes were made in the rules governing inspection performed by licensed inspectors. In the hope of being of further assistance to the wheat interests in the Northwest, a price-reporting system designed to furnish producers and dealers with comprehensive information regarding market conditions and prices at the terminals was inaugurated. In addition to this, an extensive "Know-your-own-wheat" campaign is being conducted in cooperation with the extension directors and other agencies in the States of Minnesota, North Dakota, and South Dakota. This program should aid producers to know the quality and value of their wheat and enable them to market it to the best advantage. The ruling thought is that every effort should be made to secure conditions under which the actual milling values of the wheat will be reflected in the prices received by growers. At the end of the present wheat-marketing season we should be able to appraise fairly well the value of the changes in the inspection rules and regulations and of the educational campaign.

### SHIPPING-POINT INSPECTION.

The demand for Federal inspection of farm products at points of shipment becomes more insistent. Applications for such inspection already have been received from at least 20 States. The department has found it possible to render some service at shipping points, largely in cooperation with the various States, but it is quite impossible to comply with requests for such inspection until an additional appropriation becomes available. As most of the cost of this service is defrayed from fees collected, there seems no good reason why ample appropriations should not be made. In the case of inspection at receiving points, for example, which has been longer established, the department turned into the Treasury during the past year fees to the amount of $128,000. The total appropriation for this inspection is $175,000. It is expected that both receiving-point and shipping-point inspection service will be largely self-supporting through the fees received, but as these fees go direct to the Treasury, appropriations must be made to the department. Such inspection is of great value to both producers and consumers.

### MARKET NEWS SERVICE.

Some extensions of the market news service have been made through cooperative agreements with the States, whereby the latter pay the expenses involved. Insistent demands have come for a considerable extension of this service, but have been denied because of lack of funds. It has been possible, however, to disseminate market information much more widely than heretofore through the use of the radio stations of the Post Office and Navy Departments. At designated hours each day market reports are furnished to radio stations at Washington, Omaha, North Platte, Nebr.; Rock Springs, Wyo.;

Elko and Reno, Nev.; Arlington, Va.; and Great Lakes Ill., and also to 53 stations operated by State agricultural colleges and other broadcasting agencies. As a means of getting market information to the country the radio is growing to be quite popular. This sort of service is still in an experimental stage, but gives promise of great future development and usefulness.

### INCREASED ACTIVITY UNDER THE GRAIN STANDARDS ACT.

The volume of business handled by the offices of Federal grain supervision during the past year surpassed by far that handled in any previous year. This is especially true of appeals from inspections originally made by licensed inspectors. During the year 31,689 appeals, or approximately three times as many as the preceding year, were handled by the department. In addition to the handling of appeals on complaint of parties to commercial transactions, supervisors work in close contact with licensed inspectors, aiding them in inspection problems and in applying the standards. A total of 175,896 supervision samples were handled during the year to check the work of the inspectors in order to secure correct and uniform application of the Federal standards.

The large and steady increase in demand for appeal service, as well as the desired supervision of inspections not made the subject of appeal but to secure correct and uniform application of the standards, has taxed to the utmost the personnel in some of the offices in the larger markets. This situation had become so serious by the close of the past fiscal year that it was found impossible to handle the volume of work, which by its very nature must be promptly and efficiently executed, on the available funds. To avoid a breaking down of the efficient organization which has been perfected, the only alternative was to contract the service by closing field offices. Although serious protest was made by trade organizations and individuals, it has been found necessary to close four of the branch offices.

### ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT.

During the past year there has been an unprecedented increase in the number of applications received from warehousemen who operate on a large scale for licenses under the United States warehouse act. At the beginning of the past fiscal year there were licensed 238 cotton warehouses, having a combined capacity of approximately 430,000 bales. By the close of the year this number had increased to 268 warehouses, having a combined capacity of 1,210,000 bales. The number of grain warehouses licensed under the act increased from 56, having a capacity of about 2,110,000 bushels, to 263, having a capacity of about 14,441,000 bushels. The number of wool warehouses licensed under the act increased from 5, with a combined capacity of 24,375,000 pounds, to 18, with capacity of about 27,500,000 pounds. During the year 14 warehouses controlling space to accommodate 68,395,000 pounds of tobacco were also licensed. Prior to the year 1922 no tobacco warehouses were licensed under the act. A marked interest developed also among warehousemen in sections in which no interest had been shown prior to this year.

Three important factors have contributed to the substantial progress made along this line during the past year: First, the more general appreciation on the part of bankers of the value of warehouse receipts issued under the act for collateral purposes; second, the insistence on the part of some of the farmers' cooperative associations that their products should be stored only with warehousemen who were federally licensed; and, third, the recognition accorded the federally licensed warehouse receipt by the War Finance Corporation.

## SCIENTIFIC RESEARCH.

Department workers in the field of research have been diligent during the year. Notes on work completed and progress made will be found in the reports of the various bureaus, which are being printed as separate documents, and in the various bulletins which have been issued during the year. A list of these bulletins is appended to this report. In view of economic conditions especial interest attaches to investigations which may help in reducing the cost of production, such, for example, as improvement in varieties of plants and animals, more economical cultural methods, more complete control over plant and animal diseases and insect pests which lessen returns. However unfavorable conditions may be, a lowering of the cost of production must benefit the producer.

The extensive work in testing the relative value of buds from exceptionally productive trees as compared with nonproductive ones seems to show a remarkable difference in the productivity of the resultant stock. Already this has been carried far enough with certain of the citrus fruits to impress the industry with its commercial importance. It is believed that the same principles will be applicable to many other varieties of fruits.

Continued studies of the effect of the length of day upon crop growth are yielding good results and promise to be helpful in considering varieties of plants to be used in breeding work for different regions.

Great progress has been made in recent years in solving the problem of the cause and control of many formerly obscure plant ailments, commonly spoken of as physiological diseases—such, for example, as the mosaic disease of sugar cane, corn, cucumbers, potatoes, and many other of the cultivated crops. Some of the diseases of potatoes and beets apparently belong in this same category. It is being found that these are infectious diseases which may be transmitted by different insects. Each new discovery in this most interesting field brings nearer the possibility of controlling or eliminating these troubles, or of developing varieties and strains which may be resistant to them. Much of the failure in controlling some diseases is now known to be due to failure to recognize the fact that plants might be infected and capable of transmitting the disease without showing external symptoms. These researches have resulted in throwing much light on a field in which scientific workers previously have been almost helpless.

### BARBERRY ERADICATION.

Efforts to wipe out some plant diseases by exterminating the intermediate host are encouraging. The warfare against the black-stem rust of wheat in the Northwest and against the white-pine blister rust in the forests are cases in point. The part played by the barberry in the transmission of the wheat-stem rust is now generally recognized, and scientists, extension workers, farmers, and people and communities interested in the wheat trade are cooperating in an extensive campaign to eradicate the barberry. The first annual appropriation ($150,000) for barberry eradication became available on July 1, 1918. This was increased to $350,000 on July 1, 1922. During the first two years of the campaign most of the effort was spent in getting bushes out of the cities, towns, and villages, on the supposition that the greater number of barberry bushes were located there, and also because they could be most easily and cheaply reached. In a farm-to-farm survey, which has been in steady progress during the last three summer seasons, 447 counties have been covered by squads of field men. It is estimated that it will be necessary to survey about 800 counties in all. More than five and one-half million barberry bushes have been found and destroyed. The magnitude of the task has grown as we got into it. Barberry bushes are found growing wild here and there, and especially in the timbered portions of the States bordering on the Mississippi River. The complete eradication of the bushes when they are found is more difficult than had been supposed. If portions of the roots are left in the soil sprouts may develop under favorable conditions. This makes resurveys necessary and adds much to the duration and expense of the campaign. Many bushes are found in broken or rocky ground where it is impossible to remove the roots. Experiments in the use of chemicals as destructive agents are being made and seem to offer promise. With continued appropriations and cooperation on the part of interested parties, it is believed that the campaign against the barberry can be rapidly carried to a successful conclusion.

### WHITE-PINE BLISTER RUST.

The white-pine blister rust, which has been destructive in some of the New England forests and has been mentioned in previous reports, has been found at points in the northwestern forests. A quarantine was promptly established, and by the vigorous application of methods of control which have worked successfully in the New England forests it is hoped to promptly check the spread of the disease. This disease is spread somewhat after the manner of the rust of wheat, the intermediate hosts being currant and gooseberry bushes.

### PREDATORY ANIMALS AND RODENT PESTS.

Similar to the warfare against plant and animal diseases and insect pests is the struggle to control or eradicate predatory animals and rodent pests. The annual loss to agriculture from injurious rodents has been estimated to exceed $500,000,000. This has been materially reduced through the campaigns led by the scientists of the department, which have destroyed most of the rodents on almost 100,000,000 acres of public and private land. The destruction of predatory animals which cause losses of many millions each year is progressing satisfactorily.

## ERADICATION OF TUBERCULOSIS.

Gratifying progress has been made in the campaign for the eradication of tuberculosis. All of the States are cooperating in this movement, and at the close of the year 16,216 herds had been accredited and over 100,000 additional herds had passed a first test without reactors. This widespread demonstration of the possibility of freeing individual herds from the disease has resulted in increased confidence in the area clean-up method. Already 23 States have joined in this movement. In these States more than 150 counties had completed or were in the process of testing all of their cattle and nearly 300 more were making arrangements to begin the work. Compared with the previous year, area testing has shown more than a tenfold increase. The adoption of the area clean-up method has not only reduced the expense and increased the efficiency of the work, but the results already obtained have done much to strengthen the belief that bovine tuberculosis can be entirely eradicated. Conclusive evidence is already at hand showing that tuberculosis in swine arises principally from infected cattle and that its elimination from the cattle on a given premises results in its gradual reduction in the hogs. Extensive surveys show that tuberculosis is only present in about 1 per cent of the cattle in 42 per cent of the areas of the United States, and that in a large additional area it does not exceed 3 per cent. The remaining area is much more seriously affected, but the evidence at hand indicates that this costly disease will finally yield to the scientific methods now being employed.

## THE GRADUATE SCHOOL.

The school designed to provide graduate training for scientific workers which was started in the department last year has already demonstrated its usefulness in increasing the efficiency of the scientific work. Also it has stimulated the younger of the scientific staff to increased effort to obtain adequate training. An increasing number of our scientists are taking leave of absence or arranging for part-time employment to enroll in the standard graduate schools.

This graduate school has been a factor which has made it easier for the department to enlist the interest of the better class of graduates of our scientific and agricultural institutions. Many of these are now looking forward to employment in the Department of Agriculture. The value of the work of the department and its capacity for service to the Nation will necessarily be determined by its ability to enlist trained men of the best sort. The experience so far indicates that the graduate school will be helpful in this direction.

### INCREASED SALARY STANDARD.

The Department of Agriculture has suffered for years under the limitation of the amount which could be paid to scientific workers. In the appropriation bill which was passed last spring Congress increased the scientific salary standard. The result has been decidedly helpful and has tended to check the depletion of the department's scientific force. The maximum salary now fixed is still inadequate to enable the department to meet the competition from other scientific institutions and commercial organizations, but it is a decided improvement over previous conditions in this respect.

Not a large number of promotions have been made under the permission given, but the knowledge that the opportunity for promotion is always open, combined with the opportunity for advanced training afforded by the graduate school, has contributed greatly toward raising the morale of the department workers as a whole and has resulted in a marked increase in efficiency.

### THE WAR AGAINST INSECT PESTS.

The warfare against insect pests grows in intensity. These pests are multiplying and doing increasing damage. Details of the campaigns of the past year will be found in the reports of the Bureau of Entomology and the Federal Horticultural Board.

The cotton boll weevil is now found in all the cotton-growing States. During the past year it has caused unusual damage and brought about great loss to the cotton growers. There is some impatience that our scientists have not been able to bring it under complete control. This failure has not been due to lack of effort by the department. The campaign against this pest has been waged with unremitting vigor and each year some gains are made, notwithstanding the increased damage which is being done. The results of the lime-arsenate dust treatment give increasing assurance that where this method of control is properly applied it will be found most helpful.

The method is still expensive, however, and we have not yet been able to reduce the cost to the point where it can be profitably used on land which grows less than one-half bale of cotton per acre. During the summer experiments made in cooperation with the Air Service of the War Department give hope that the use of airplanes for the distribution of poisons may not only reduce the cost but extend the use of such poisons generally in the communities.

The fight against the pink bollworm, which is regarded as an even more serious pest than the boll weevil, has given us great encouragement. This pest had gained limited foothold in Texas, Louisiana, and New Mexico. As a result of a conference of representatives from the cotton States, held in the early summer of 1921, changes in State laws were made which permitted more complete cooperation between the department and the States. With this enlarged authority our operations in Texas have been highly successful. The two worst infested areas in that State have been cleaned up. New outbreaks which appeared in two Texas counties in 1921 were attacked vigorously and up to 1922 recurrences of the pink bollworm have been determined in but three fields, these being on the Rio Grande in the Great Bend district, where trouble is always to be expected because of its proximity to Mexico. As an illustration of the need of constant watchfulness, an inspector of the department found in the personal baggage of a passenger landing in Baltimore from Brazil last summer some fifty-odd packages of Brazilian cotton seed, all infested with living pink bollworms. The passenger who brought these had intended to take the seed to the cotton section of Mississippi for planting. Had this been done, in all probability the fight against the pink bollworm would have been lost. The fact that there was an inspector at this port at that particular time and that he was zealous in his duties undoubtedly has saved the cotton States many millions of dollars.

The Japanese beetle, which came to us with a shipment of Japanese iris, has become a serious pest, apparently one of the most dangerous insect introductions made in many years. In the area of original infestation, where the insect has become most abundant, the damage to foliage and fruit is very alarming. This original area was quarantined, and this has checked the rapidity of the spread of the insect, but it is extending its operations at the rate of about 5 miles a year, and at any time may make extended jumps. During 1921 in some 200,000 baskets of sweet corn which moved out of the infested district upward of 5,000 beetles were found. The insect may be carried by almost any of the farm, garden, florist, or nursery products, and also is a strong flyer. Hope of eradication was early abandoned, and while the rapidity of its spread can be retarded by efficient quarantine, there seems no question but that in time this pest will spread throughout the United States. Holding it in check by means of a quarantine is important, in that it gives time to study methods of control, and especially to find and introduce natural enemies upon which we must rely for the most effective control. Large shipments of parasites of this Japanese beetle have been received.

No new outbreak of the corn borer has been reported this year, but it has maintained itself in the previous areas of infestation. A correct estimate of the damage which may be done by this pest can not now be made, but there seems no doubt as to its threatening character. It may prove to be a very serious pest when it reaches the great Corn Belt, and particularly when it gets into the more southern regions of corn culture. Therefore, quarantine and control measures should be used vigorously. A hopeful development has been the discovery in the south of France of what seems to be a rather effective parasite of the corn borer. This parasite has been introduced and established in Massachusetts. Also, judging from laboratory studies, this same parasite will attack the native cornstalk borer in the Carolinas and the sugar-cane borer in Louisiana. Apparently, also, it will destroy the larvæ of the codling moth of the apple. It seems to be a benevolently active parasite, and everything possible is being done to make it at home here and encourage its multiplication.

### THE NURSERY-STOCK, PLANT, AND SEED QUARANTINE.

For over three years Quarantine 37 has been in force. This quarantine regulates and conditions the entry of foreign plants and seeds for propagation. It has been severely criticized, both by importers and many amateur florists and horticulturists. To give full opportunity for such criticism and for considering it on its merits, I called a conference at Washington in May of 1922. This conference was largely attended by representatives of the various trade associations, horticultural and agricultural societies and associations, both regional and national, and officials of the various State horticultural agricultural, and quarantine agencies. In addition, there were many individuals interested in horticulture, as well as delegates from England, Holland, Belgium, and France. This conference was helpful in making clear the conditions which led to the establishment and enforcement of the quarantine, and many who have been very critical found reason to modify their views and their criticism. While from time to time it may be possible to make changes which will render this quarantine less burdensome and annoying, the need for it seems very clear. Most of our damaging insect pests have come with imported foreign plants. Even on the plants which were permitted entry under the quarantine during the last fiscal year there were intercepted about 500 different species of insect pests and also a considerable number of plant diseases.

### PROPOSED BUREAU OF HOME ECONOMICS.

In the budget submitted for the coming fiscal year congressional authority is asked to create a bureau of home economics as one of the scientific bureaus of the department. The work in home economics was established in connection with the States Relations Service, and its development has been largely for the purpose of furnishing information and assistance to extension workers. The establishment of a separate bureau of home economics with a technically trained and experienced woman as chief should enable us to extend our work in that field and render better service to the workers in the farm home and rural community. Properly extended, the work in home economics is so broad that it embraces relationships with nearly all the fundamental sciences. For example, different phases of nutrition work are already under consideration in three different bureaus, work with textiles in two bureaus, household equipment in one, household management in another, while work in dietetics, foods, cooking, clothing, and household decoration already is organized in our economics department. With the organization of a bureau of home economics it will not be difficult to bring about coordination and cooperation of the work already being carried on and to begin research in new fields which must be explored scientifically if the department is to render the greatest service to the home maker.

### THE FOREST PROBLEM.

The necessity of working out and applying a comprehensive plan for protecting, regrowing, and utilizing our forests becomes more obvious with each succeeding year. We now consume timber four times as fast as we grow it. At the present rate of wood consumption we should have about 4 acres of productive forest land per capita, and these acres should grow wood at the rate of about 50 cubic feet per acre per year to supply a population equal to that shown by the 1920 census. This production of wood can not even be approximated unless we become more skilled in the art of growing and managing forests and of utilizing forest products with economy. This requires cooperation between the Federal Government and various States and the owners of private forest lands. The desire for such cooperation seems to be increasing on the part of all. There was a time when Federal efforts toward developing a constructive forest policy were resented by owners of forest lands. Gradually that attitude has been changing, and during the past 18 months I have had many evidences of both the willingness and the earnest desire of timber owners to avail themselves of Federal cooperation and technical skill.

Through force of circumstances the main effort of the Department of Agriculture in its dealing with the forest problem has been to manage and protect the great national forests. In my report of last year I dealt somewhat at length with the general policies which have been followed in forest administration. These policies should be extended to cover the whole forest area of the United States, classing as forest area all land more suitable for timber production than for other purposes. The more quickly provision is made for this the better.

Equal in importance to the growing of forests and protecting them is the best possible utilization of the wood. It would be very wise to enlarge the work of the department in the scientific study of wood utilization. The work it has been able to do in its forest products laboratory in Wisconsin has borne rich fruit and has won grateful acknowledgment from wood users of all kinds. The extension of such work as rapidly as possible will prove highly profitable to the general public. We are finding that the consumption of wood for many purposes can be greatly lessened through a better understanding of how to use it most efficiently, and that much inferior wood can be utilized to good purpose.

The establishment of additional forest experiment stations, especially in the Lake States and in the New England area, is much to be desired. At such stations we are able to make close-at-hand studies of matters affecting forest growth which can not possibly be made so well in any other way.

### FOREST LEGISLATION NEEDED.

If it were feasible to enact a law which would provide for the administration of all our forests, National, State, and privately owned, under rules and regulations which would compel intelligent cutting, adequate protection, and economic utilization, that would be the best thing that could be done for the good of all the people. Such legislation does not seem feasible at the present time. It should be possible, however, to enact some legislation which will have the support of the most forward looking people interested in our forests, and I sincerely trust that this may be done soon. Such legislation should provide:

First, for the extension of Federal cooperation with the States in the protection of forests in State or private ownership, making such cooperation contingent upon equal expenditures by the cooperating States and also upon their compliance with adequate standards of protection. The limited cooperation which has been possible under present conditions has been very successful, and I think it is generally agreed by those who are familiar with this matter that larger investments of public funds in cooperation with the States and with private owners would do more to stimulate timber growth than anything else that can possibly be done. The annual loss (amounting to about $16,400,000) from forest fires and the continued unproductivity of much of our land is a shocking waste which should not be tolerated by an intelligent people. This loss can mostly be stopped through such cooperation as I have indicated. The use of Federal funds for the organization of a strong Federal agency for this purpose is justified to exactly the same degree that the use of the funds of the city for the organization and maintenance of a fire-fighting department is justified.

Second, for more complete cooperation with the States in growing and distributing forest-planting material. In most States there are regions better suited for timber growth than for any other purpose. Federal aid would have powerful and far-reaching effects in establishing new forests where they are most critically needed.

Third, for the purchase of timberland, which has been carried on under the act of March 1, 1911, should be extended as rapidly as the condition of the Public Treasury will permit. Such purchases represent money invested and not money spent. The lands already purchased could be sold for more than they cost, and as the timber grows they will increase in value and become a continuing source of national income. Aside from the direct value of such lands, such Federal enterprise serves as an educational stimulus to the reforestation of near-by lands in private ownership, which is greatly to the public benefit.

Fourth. There are large areas of lands in the unreserved public domain which are better suited to timber growth than to any other purpose, and similar large areas in Indian reservations which will ultimately be withdrawn as tribal properties and thrown open for other disposition. All of such lands ought to be included within the national forests. The practical way to do this is to authorize the President, with the assistance of some agency, such as the National Forest Reservation Commission, to classify and dispose of these public lands in accordance with their character and place in the national forests such lands as are best suited for forest purposes.

Fifth. Provision should be made for research in the growing and utilization of timber on a scale adequate to present needs. While we are advancing rapidly in acquiring technical information, our present research agencies can not meet the demands of the existing situation as to timber use or new timber growth.

Legislation which would include the five matters before mentioned ought to be enacted at the earliest possible date. It would give the opportunity for the working out and application of a forest policy suited to the needs of the Nation. When we look about us and see the extent to which we use wood in our daily lives and then reflect upon the fact that we are cutting down our forests four times as fast as we are growing them, the urgent need of developing a comprehensive forest policy without further delay should be recognized by every man in a position of legislative or administrative responsibility.

## FIGHTING FOREST FIRES.

Very substantial progress was made during the fiscal year in checking the inroads which forest fires are making in the timber resources of the Nation. During a season of unusual hazard the fire-protective organization on the national forests of the West was brought to the highest pitch of efficiency it has ever yet reached, with the result that in most cases threatening fires have been reached promptly and suppressed with the minimum of loss and expenditure. However, the greatest progress has been made in bringing under protection privately owned timbered lands. The increase in the appropriation from $125,000 to $400,000 for cooperation with the States in protecting forested watersheds of navigable streams, made possible a very material extension of the work. The area placed under protection during the past year was increased by 26,000,000 acres. At the same time the protective force was strengthened and improved in regions where the smaller appropriations of the past have admitted only the retention of a mere skeleton fire-fighting organization. Cooperation was established with two additional States—Ohio and Tennessee—making the total number now 26. The additional funds made it possible to meet emergency conditions in several States where the fire hazard this year was unusually great.

The appropriation of Federal funds for this purpose has stimulated local interest in the efforts to safeguard the essential raw material represented by their forest areas. During the fiscal year 1922 the 26 States cooperating with the department in fire protection along navigable streams expended for that purpose from their own funds a total of $1,897,000, an increase of about $830,000 over the expenditure of the previous year. In addition to these public expenditures, private owners expended approximately a million dollars in the protection of their forests against fire. Federal leadership has heartened both the States and the private owners in undertaking this work, with the result that a very substantial forward step has been made in checking the red scourge.

According to the best information obtainable by the Forest Service, there has been an average of 33,500 fires annually during the past six years, burning an average area of 7,088,000 acres and involving an average annual immediate property loss of $16,424,000. The greatest loss and the greatest number of fires now occur in the regions not under cooperative protection. About one-half the forest lands of the country outside the national forests are now receiving some form of systematic fire protection, but 166,000,000 acres of forest lands are still wholly unprotected from fire and the annual loss in such regions is appalling. We can not as a people rest content with such a showing. Such wholly unnecessary destruction must be stopped.

## FEDERAL-AID ROAD CONSTRUCTION.

Ten thousand two hundred and forty-seven miles of road projects were brought to completion during the year through Federal aid to the States. Prior to the fiscal year 1922, 7,469 miles had been completed. This brings the total completed up to the end of the fiscal year to 17,716 miles. The mileage completed during the year under the Federal-aid system is classified as follows:

| | Miles. |
|---|---|
| Graded and drained | 2, 060 |
| Sand-clay | 1, 210 |
| Gravel | 3, 842 |
| Waterbound macadam | 265 |
| Bituminous macadam | 370 |
| Bituminous concrete | 400 |
| Concrete | 1, 915 |
| Brick | 165 |
| Bridges | 20 |
| Total | 10, 247 |

At the close of the year the projects under construction, amounting to approximately 14,500 miles, were estimated to be about 56 per cent complete.

The total apportionment of Federal funds to the States, up to and including the fiscal year 1922, amount to $339,875,000. Of this, $297,018,923 had been set aside for definite projects, many of which had been completed prior to the close of the year, others placed under construction, and still others which were more recently approved were awaiting construction. The amount of Federal aid paid or due on completed projects up to the end of the year was $132,079,204. The total cost of these projects, more than 50 per cent of which has been paid by the States, was $309,466,524.

On projects under construction at the end of the year Federal aid has been allotted to the amount of $109,989,757. The estimated total cost of these projects is $254,269,813. The total amount of Federal aid actually paid to the States on completed and uncompleted projects up to the end of the year was $166,911,552. During the fiscal year the total amount paid out of the Treasury was $88,216,122, which is greater by almost $10,000,000 than was paid during the five years previous. Of the appropriations made by the Federal Government there remained unobligated at the end of the fiscal year $42,856,079.

At the present rate of building not many years will be required to give the Nation a connected system of good highways in all directions. During the fiscal year 1922 Congress enacted legislation providing for the designation of a system of Federal-aid roads in all States to consist of not more than 7 per cent of the total mileage of roads in the States and authorizing appropriations of Federal aid in the construction of this system in the amount of $50,000,000 for the fiscal year 1923, $65,000,000 for the fiscal year 1924, and $75,000,000 for the fiscal year 1925, thus determining and indicating to the States in advance of the actual appropriation of funds the amount of Federal aid to be extended, and consequently the rate at which the building of highways under this plan is to progress during the three ensuing years.

The department is pursuing its scientific studies of road construction, maintenance, and design. Out of these studies is coming much exceedingly valuable information, which should result in both greater efficiency and greater economy in our road-building enterprises.

### NATIONAL FOREST ROAD AND TRAIL CONSTRUCTION.

During the fiscal year approximately 1,100 miles of national forest roads and 3,000 miles of trail were constructed by the department, bringing the total mileage of roads constructed in the national forests from Federal funds, supplemented at times by local cooperation, to nearly 5,000 miles and the total of the forest trails up to approximately 7,000 miles. The total expenditures to date for this type of work amounts to approximately $17,000,000.

### EXTENSION ACTIVITIES.

In compliance with the mandate of the law which created the Department of Agriculture, to " diffuse among the people of the United States useful information on subjects connected with agriculture, in the most general and comprehensive sense of that word," the extension activities of the department take various forms. There are now about 4,000 persons employed in cooperation with the State agricultural colleges. Agricultural agents are employed in about 2,100 counties, home-demonstration agents in 800 counties, and club agents in 200 counties. In addition, there are 750 district agents and specialists in the preparation of subject matter who cooperate with the county extension workers. It is estimated that through the extension personnel the department comes in contact with about 2,500,000 farm homes. The 491,000 boys and girls enrolled in club work report products valued at more than $7,000,000. Of the field agents, 272 are colored and work to aid negro farmers. About $7,000,000 of Federal money was spent for extension work during the past year, to which was added about $9,700,000 of State money.

## PUBLICATIONS.

Other agencies used in diffusing information to the people are bulletins, pamphlets, and periodicals, motion pictures, exhibits at State and district fairs, and mimeographed material distributed to the press. As indicated in my report for 1921, careful consideration has been given to our publications. A committee of editors was called in last year and asked to make a thorough study of the various publications of the department and suggest such changes as they thought desirable to make such publications more helpful to the recipients. Most of the suggestions made by this committee have been acted upon favorably. The demand for the publications of the department is indicated by requests voluntarily made for them. During the past year not less than 650,000 requests for publications have been received in addition to the 33,500 received from Members of Congress. Fifty-eight new Farmers' Bulletins were printed, aggregating 1,738,379 copies; 108 new Department Bulletins were produced, in the total number of 577,800 copies, while 525,000 copies of 43 new department circulars were printed. When to these new publications is added the number of old publications reprinted on demand, we find that during the fiscal year the printing of publications of the department reached a grand total of 36,026,334 copies.

The distribution is more efficient than for some time past. At our request, representatives of the Bureau of Efficiency have aided in a revision of the mailing lists, which has resulted in a considerable saving in mailing work. No names are kept on our distribution lists except upon special request, and there is no automatic distribution of all the department's bulletins except to libraries and other institutions which need them.

The educational motion pictures of the department are growing in favor; 33 new films were completed, and 21 old films revised. Work was begun on 28 new subjects. The department now has a total of 547 reels available for distribution. Pictures are circulated by extension workers and schools. It is estimated that the department films are seen each year by an audience of between four and five million persons.

The department exhibits were displayed at more than 60 fairs and expositions and special shows, at which the total attendance was more than 4,000,000. The form of presentation of these exhibits has been much improved. An attractive exhibit for the Brazilian International Centennial Exposition at Rio de Janeiro, depicting the agricultural resources and development of the United States, was designed, prepared, and shipped to Brazil.

### REORGANIZATION OF EXTENSION WORK.

As a result of special study of extension activities of the department it seems desirable to reorganize this work to some extent. At the present time there is no one person who is charged with the responsibility of coordinating all of the extension work of the department. In the Budget for the ensuing year I have asked Congress to provide for a director of extension work, and in the meantime I am shaping our work with a view to such reorganization. It is the plan to bring under this directing head all of those offices which have to do entirely with extension work. These are the office of cooperative extension work now in the States Relations Service, the office of motion pictures in the Division of Publications, and the Office of Exhibits temporarily attached to the Assistant Secretary's office. These offices, in addition to the editorial office, are the ones through which the bureaus find expression for the work which is ready for presentation to the public. The plan will make unnecessary the States Relations Service, the office of the director of information, and the Division of Publications, and when put into effect will do away with them as such. The other offices in these divisions will be placed under the supervision of the director of scientific work, the director of regulatory work, or within the Secretary's office proper.

I plan to attach the editorial and distribution work direct to the Secretary's office, and have asked Congress in this year's Budget to provide for a new position of an assistant in charge of the editorial office, with a salary sufficiently large to attract a capable man for this important work. It is the plan to place him in charge of all the editorial work. During the past year we have given particular attention to the statistical accuracy of the Department Bulletins. The duties of the assistant in charge of editorial office would include this supervision.

## PACKERS AND STOCKYARDS ACT.

The packers and stockyards act, which provides for Government supervision, through the Secretary of Agriculture, of meat packers, of stockyards, and of stockyards agencies, such as live-stock commission merchants, was enacted in August, 1921. The constitutionality of the act was attacked in the courts and the setting up of the organization necessary to carry out the provisions of the act was therefore delayed. Its constitutionality was fully upheld by the Supreme Court of the United States in May, 1922.

The packers were subject to the act immediately upon its passage, and no registration or other special formality was necessary. A survey of the stockyards resulted in finding 78 of such yards in 70 cities in 35 States to be subject to the jurisdiction of the Secretary of Agriculture, and these stockyards have been formally posted as required by law; 1,075 market agencies and 3,436 dealers at these markets are registered under the law, and the schedules of rates and charges of the stockyard companies and commission men have been published and filed. Resident market supervisors have been assigned to 19 of the stockyard markets, and these supervisors have been given jurisdiction over the remaining markets which were not considered sufficiently large to justify resident supervisors. General rules and regulations governing stockyards and market agencies and dealers have been adopted and put into effect.

The various agencies which come under the provisions of the act have shown a disposition to cooperate in its enforcement, and this has made it possible to correct many practices through conference and without formal proceedings. Through such conference the use of butter packages containing less than pounds and even fractions of pounds has been discontinued and the principle of standardization of retail packages has been accepted by the packers. Audits of the books of commission merchants in some yards revealed conditions which clearly needed correction, and satisfactory progress in this direction has been made. An offensive boycott by one group of market agencies against another at one of the principal stockyards was promptly stopped, and the principle of open, competitive marketing established. Certain arbitrary price discriminations working to the injury of live-stock owners are being brought to an end, and actual market values substituted in the sale and purchase of live stock. Complaints against commission charges in one market and the announcement that formal hearings would be held resulted in bringing into conference representatives of the commission merchants and of the live-stock shippers tributary to that market. At this conference it was agreed that the matter of the reasonableness of commission charges should be informally submitted to representatives of the Department of Agriculture without the expense of a formal hearing, and that all parties would abide by the decision rendered after such informal hearing. Developments so far indicate that there is a growing spirit of understanding and willingness to cooperate between the traders on the various markets, the packers, and the stockyards agencies.

In the enforcement of this act the dominating thought is to bring about harmony and cooperation and remove cause for antagonisms, misunderstandings, and irritations, to the end that confidence in the manner in which live stock is marketed shall be established.

### THE GRAIN FUTURES ACT.

In August, 1921, Congress enacted the future trading act, which provided for governmental supervision, through the Secretary of Agriculture, over future trading on grain exchanges. An appeal was made to the courts, and in May, 1922, the Supreme Court of the United States rendered a decision which invalidated the regulatory portions of the act. The decision, however, pointed the way to the enactment of legislation which should accomplish the purposes of Congress, and such legislation has since been enacted under the interstate power of Congress. The constitutionality of the new act has in turn been attacked, and pending the decision of the court little progress can be made in its enforcement.

The tax imposed by the act of August, 1921, on transactions known as "privileges," "bids," "offers," "puts and calls," etc., was upheld by the Supreme Court, and the result has been that these transactions have been discontinued. In addition, the Supreme Court expressly stated that its decision did not affect the duty placed on the Secretary of Agriculture by the future trading act to investigate the facts about grain-marketing conditions. Representatives of the department have therefore been maintained at Chicago and Minneapolis, where they have kept close observation over the operations of the exchanges and have compiled a large amount of information as to the volume and course of transactions on the exchanges. This information will be helpful in carrying out the provisions of the new law.

The requirements of the new law, which becomes effective on November 1, 1922, are substantially the same as those of the one declared unconstitutional. There is no interference with "hedging" transactions on the boards of trade or with the ordinary speculation or buying and selling of contracts for future delivery. If there should be evidence of undue manipulation or attempts to corner the market, or of the dissemination of false or misleading information about crop or market conditions by members of the exchanges, such matters will be inquired into and promptly dealt with as required by the statute.

The Secretary of Agriculture is given authority to examine the books and records of the members of the exchanges and to require such reports as may be necessary to carry out the provisions of the act. There is thus an opportunity to make a thorough inquiry into prevailing systems of grain marketing and to secure information which has never heretofore been available, and which is urgently needed before important changes in marketing methods can safely be required.

### A BUILDING PROGRAM FOR THE DEPARTMENT.

In my annual report last year I called attention to the fact that the offices and laboratories of the Department of Agriculture in Washington are scattered in more than 40 buildings in various parts of the city. There has been no improvement in this situation and, due to the lack of centralized housing facilities, there continues to be a tremendous waste of Government time and money. A satisfactory and efficient administration of the work is impaired by difficulty of personal contact between the Secretary and the officers of the department, as well as between bureau chiefs and units of their own respective bureaus. One bureau of the department alone is housed in nine separate buildings, some of them widely scattered. It is impossible to overemphasize the need for a centralized housing of the department activities.

During the year we have been busy on this problem, and a housing committee, of which the Assistant Secretary is the chairman, in cooperation with the architects of the Treasury Department, has prepared with great care a proposed building program, which if carried out will house practically all branches of the department in Washington in buildings to be erected on or adjacent to the department reservation on the Mall. The proposed program contemplates: (1) The acquisition of ground south of the department's reservation and construction thereon of a plain office-type building of six or eight stories. The estimate of the cost of such a building, including the site and enlargement of the power plant of the department, is $4,350,000. This would do much to meet the most pressing housing need of the department, as it will provide a building of large capacity, and it can be constructed at this relatively low cost for the reason that it would not be located on the Mall, and therefore can be erected as a plain office building without interference with the plans for the beautification and development of the Mall. (2) The next most pressing need is for the completion of the central section connecting the two existing marble structures now occupied by the department on the Mall, known as the east and west wings, at an estimated cost of $2,000,000. The two wings were completed in 1908 and have been used by the department since that date, but no funds have been available for the construction of the central portion of the building. (3) When these two projects have been completed, the construction is proposed on the northern end of the department's reservation on the Mall of a portion of a building of suitable construction facing south with several wings extending toward the north, the approximate cost of which would be $6,000,000, and (4) the completion of the proposed building on the northern end of the reservation by the construction of a north façade, at an estimated cost of $3,000,000. While this program will involve an ultimate outlay of $15,350,000, it could be started with an initial expenditure of $3,000,000 for the first year and approximately the same amount during the second year, and the remainder could be extended over a period of years.

This is one of the fundamental needs of the department which has been recognized by all who have had any connection with the housing of the Government departments in recent years, and I urgently recommend that it be provided for as soon as the state of the Nation's finances will permit. In the meantime, at my request, experts of the United States Bureau of Efficiency are making a survey of the present space arrangements in the department with a view to affording such relief, if any, as may be possible by regrouping of the space assignments pending the provision of suitable and adequate housing for the department.

### NEW SEED-GRAIN LOANS.

The act of March 20, 1922, authorized the making of seed-grain loans in crop-failure areas for the crop of 1922, and appropriated $1,500,000, to be expended under the direction of the department, for that purpose. Under the provisions of this act, $1,463,812.69 was loaned to 11,968 borrowers in the States of Idaho, Montana, North Dakota, South Dakota, and Washington. The total expense of making the loans was less than $20,000.

### COLLECTION OF SEED-GRAIN LOANS.

During the spring of 1921, under the authority contained in the annual Agricultural appropriation act, approved March 3, 1921, a total of 13,935 seed-grain loans was made by the department in Montana, North Dakota, Idaho, and Washington, aggregating $1,954,929. These loans were made at a cost of approximately $16,000 for administrative expenses and $5,000 for recording fees for crop mortgages. Crop conditions generally throughout the seed-loan territory were poor during the following season, and collections during the winter months and up to June 30, 1922, amounted to only $668,742 on the principal of the loans and $1,415 on the interest. The expense of making these collections was approximately $25,000. So far as practicable, borrowers who were unable to repay their loans were required to renew their promissory notes and execute new mortgages on their 1922 crop as security. At the close of the fiscal year 1922 there were outstanding unpaid seed-grain loans for the two years amounting to approximately $2,750,000. The urgent deficiency bill approved July 1, 1922, appropriated $50,000 to cover the expense of collecting the unpaid seed loans during the fiscal year 1923. Crop conditions in the seed-loan territory are now more favorable than for several years in the past, and the department is proceeding with collections.

### MESSENGER SERVICE.

Because of the widely scattered locations of the forty-odd buildings occupied by the department, it is necessary to employ a large number of messenger boys. Approximately 200 such employees are on the rolls in Washington. During the year the department has devoted especial attention to the situation surrounding the employment of these boys. Under existing regulations the position of messenger boy is not regarded as in the apportioned service. It is virtually impossible, therefore, to promote these boys to higher clerical positions, regardless of how deserving or capable they may be. As the service promises no future for them, the department is unable to secure and retain the most desirable boys. Thus, we have a situation altogether contrary to that which usually prevails in any well-managed private business. The experience in this department indicates that it probably would be advantageous to bring about a change in the existing regulations so that it would be possible to promote deserving messenger boys to clerical positions where they indicate a marked capacity for growth in the service. The department has felt considerable responsibility for the welfare of these employees and during the year has given especial attention to improving their general conditions. With the cooperation of the Public Library, reading courses in standard works have been prepared and made available to them. Meetings of these employees have been held and every effort made by the department executives to urge them to take advantage of the free evening schools. One hundred and twenty-eight, or 64 per cent of the total number employed in Washington, have registered for evening instruction.

After consultation with the agencies in Washington working with boys, arrangements have been made by which physical instruction and direction is given once each week in the Y. M. C. A. gymnasium. A simple supper follows the gymnasium hour, at which talks are made by Government and other people with the object of interesting the boys in self-improvement.

### ECONOMIES EFFECTED IN THE DEPARTMENT.

In the administration of the work during the fiscal year the urgent necessity for economy in governmental expenditures has at all times been kept in mind by the officers and employees of the department. In conformity with the plan established by the Bureau of the Budget, reserves amounting to $1,406,984 were set up against the various annual appropriations of the department. By the exercise of strict economy at the close of the year the department was able to add further unused balances in the amount of $678,749, and this, together with the $1,406.984 reserved, made total savings of $2,085,733 turned back to the Treasury in the form of unexpended balances from the annual appropriations.

In addition to the foregoing, a reserve of $559,569 was set up from the so-called continuing appropriations of the department, which are available until expended. While this money will eventually be expended, it was found possible, under the necessities of the times, to defer the expenditures beyond the present fiscal year, and thus, for the present, to save the withdrawal of the cash from the Treasury.

The efforts toward reduction in expenditures were not confined merely to keeping intact the reserves reported in the foregoing. The business administration of the department generally has been subjected to close scrutiny and specific economies inaugurated all along the line. The department has been actively represented on the various coordinating agencies created under the authority of the Bureau of the Budget. A traffic manager has been appointed to coordinate and handle the large volume of shipments and extensive passenger movements in connection with the work of the department. Careful attention has been given to economies which might be effected by changes in organization, and worth-while results have been achieved in this direction also, some of which will be mentioned later.

Particular attention has been given to the purchasing work of the department. After a survey of this work was made by an expert detailed from the Bureau of the Budget, a director of purchases and sales was designated to coordinate the purchasing work and the disposition of surplus property. Changes have been made in former procedure. The work has been placed upon a more businesslike basis by a closer scrutiny of purchase requirements. By reorganization and extension of the powers of the department board of awards competition has been widened on supplies and equipment bought. By consulting with commodity experts in this and other departments prior to purchasing, the department has kept informed on market conditions in various lines and has been able to place orders more advantageously. The purchase of certain commodities has been centralized for Washington and near-by field stations, enabling the department to secure better prices by quantity orders.

Investigation is constantly being made into the availability of surplus property from other departments and its use wherever economical instead of the purchase of new equipment by the department. The stocks and equipment of the entire department itself have been gone over carefully, both in Washington and in the field, and under a system which has been established a large amount of surplus equipment for which the holding bureaus have no further use is furnished to other bureaus, thus avoiding additional purchases. Serviceable motor trucks have been secured at nominal costs from surplus stocks of other departments to replace worn-out trucks in the centralized trucking unit of the department, making better hauling service available to the bureaus at lower cost. The revenues from the sale of perishable products from the field stations of the department near Washington have been more than doubled by a special order issued during the year centralizing all such sales in the department's supply division.

To summarize, here as elsewhere in the service, "Economy with efficiency" has been the watchword. The constant aim during the year has been to develop a consciousness on the part of each officer and employee of the department of the necessity and personal responsibility on his part for the maximum efficiency and economy with respect to his own particular work and the items of expenditure with which he may have to do. Economies and increased efficiency effected in this way in connection with the routine business operation of the department can not be adequately measured by figures, but they are of fundamental importance as the sound foundation of the whole economy program. The record of the year includes gratifying reports of this type and reflected increases in the efficiency of the lines of work affected. A few typical instances are interesting.

Reduction in manufacturers' price of automobiles and tires and tubes for field use taking place after proposals had been submitted to the department have been secured by the board of awards calling for revised prices instead of accepting the bids as originally submitted.

A department shop for the repair of awnings has been established at a saving of approximately $3,000 a year. Facilities for the repair of typewriters and bicycles by the department itself are being established at material savings over the prices formerly paid to commercial concerns for these services. The installation of new equipment in the central power plant of the department made possible a reduction in force of six firemen and one engineer and reduced the annual consumption of coal by approximately 400 tons.

In the Fixed Nitrogen Research Laboratory of the department a change of grate bars in one of the heating plants saved $500 a year on the coal bill. By redesigning certain electrical equipment enough electrical energy has been saved to operate a battery of electrolytic cells to enable the laboratory to make its own hydrogen, effecting a saving of over $4,000 a year in the purchase of liquid ammonia. This branch also effected a saving of $13,000 during the year in reduction of personnel.

A revision of all of the mailing lists of the department conducted with the assistance of the United States Bureau of Efficiency resulted in the elimination from the lists of more than 100,000 names and addresses. One list of 8,000 names was discontinued altogether, saving 344,000 Government bulletins a year, or an annual expenditure of more than $7,000.

The addressing and duplicating work for all of the bureaus has been consolidated under the Division of Publications, resulting in a reduction in personnel and the release of $20,000 worth of machinery to the General Supply Committee for assignment to other departments. Better methods of management applied to the conduct of the duplicating work as a centralized activity have reduced the percentage of wastage of paper by 75 per cent.

Three separate periodical publications, The Market Reporter, The Monthly Crop Reporter, and the National Weather and Crop Bulletin, were combined during the year into one periodical, known as Weather, Crops, and Markets, and marked savings were thereby effected. Another periodical which duplicated much of the material sent out through the regular channels was discontinued altogether. A relatively expensive information service to the press was discontinued and in its place was substituted a more extensive service to newspaper syndicates at practically no expense to the Government. At the close of the year the department turned into the Treasury from the appropriation for printing and binding an unexpended balance of $183,848.

In the Forest Service, a bureau having extensive field operations, an estimated saving of 25 per cent in its annual telegraph bill of $10,000 is being accomplished through increased censorship. Through centralized purchase direct from producers, savings of not less than 15 per cent are being effected from an annual expenditure exceeding $300,000 on the purchase of smoked meats, canned goods, and dried fruits, and the quality of food used for the maintenance of field parties on road and trail work in the forests has at the same time been improved. Inspection and administrative trips are planned in accordance with carefully worked-out schedules in order to secure for the Government the advantage of specially reduced round-trip rates. By this means an average saving is made of $50 per person traveling out of Washington for western points during the year. In order that the maximum amount may be available for the purchase of essential supplies and equipment for the field operations of the service, the purchase of office furniture has been stopped altogether. Seven thousand dollars have been saved in this way during the year and applied to the more urgent needs of the service. The headquarters of the bureau at one western point has been removed to cheaper quarters at an annual saving of approximately $10,000.

In the Weather Bureau a demand for $11,320 additional funds required to meet increased rental charges on expiring leases was met by reducing the number of rooms occupied by the field offices of the bureau involved so as to keep within the existing allowance for rentals. The same situation arose July 1, 1921, and was met in a similar manner, notwithstanding the offices of the bureau have been crowded thereby.

The consolidation of the Bureau of Markets and the Bureau of Crop Estimates on July 1, 1921, resulted in savings of approximately $30,000 through the reduction of the personnel engaged on administrative work. A similar consolidation of administrative services was effected on July 1, 1922, when the Bureau of Markets and Crop Estimates was further merged with the Office of Farm Management and Farm Economics to form the new Bureau of Agricultural Economics, in which the economic work of the department is now centralized. It is estimated that an additional $30,000 was saved in overhead expenditures by this consolidation. In addition, the consolidation has made possible the coordination of the work of various technical divisions of the three former bureaus, thereby eliminating duplication and overlapping throughout the economic units.

In the Insecticide and Fungicide Board the field work has been redistricted, resulting in a saving of approximately $1,500 a year without loss of efficiency.

In the States Relations Service, by the consolidation of the two Washington offices engaged in directing the work of agricultural extension, salaries aggregating approximately $20,000 have been saved, and as the result of centralizing and rearranging the clerical work in the administrative offices of the same bureau salaries of clerks to the amount of $8,000 have been saved.

One field office of the Bureau of Animal Industry was discontinued during the year and the work of that office consolidated with another, resulting in a saving of approximately $4,000. Two divisions of the bureau in Washington were merged, resulting in the saving of the salary of one chief of division and one clerk, amounting to $5,070. By consolidating the work of an employee on the Canadian border with the duties of another inspector, a saving of $1,500 was effected, and the recall of one inspector from overseas has resulted in a further saving of $3,300. In the meat-inspection service, by realignment of the force, the actual expenditure during 1922 was reduced several thousand dollars, notwithstanding the fact that nearly 1,000,000 more animals were slaughtered under inspection during the year and almost 300,000,000 more pounds of meat food products were reinspected, thus avoiding the necessity for additional appropriations. In the work of supervising the preparation of biological products a saving of approximately $4,000 was accomplished through reduced travel. During the year there were produced 3,037,771 more doses of tuberculin than in the fiscal year 1921, and this was accomplished at a saving of $20,885 over the amount expended during the previous year. The manufacture and distribution of blackleg vaccine was also discontinued on July 1, resulting in a saving of $10,000 per annum.

In the Office of Exhibits the agricultural displays have been prepared in such manner that they can be used a number of times without replacement, whereas formerly the department exhibits frequently were suitable for use during one or two seasons only.

In the Bureau of Biological Survey it was possible during the year to use $20,000 of the money set aside as a reserve to enable the department in cooperation with one of the Western States to cope with a serious outbreak of rabies among coyotes which threatened to spread into other stock-producing States. As a result of the availability of the money previously reserved, the outbreak was brought under control. If the reserve had not been available it would have been necessary for the department to have asked the Congress for an additional appropriation in connection with this emergency.

The economies listed above are typical of the spirit in which the department has entered into the plan to conduct the business of the Government on the most economical and efficient basis possible.

While, as pointed out in the foregoing, we have been able to make a great many very substantial savings in money expended through the application of modern business methods, it is increasingly evident that the largest economies to be effected in the department are those which come as a result of efficient organization. Such economies can not be expressed in dollars and cents. They are measured rather by the larger effectiveness of the work and the amount of work done for the money expended. The reorganization which resulted in bringing three units into one in the Bureau of Agricultural Economics is a case in point. This reorganization effected considerable savings which can be measured in money, but altogether the larger savings have come through the increased efficiency and better administration of the work done in this particular field. I am quite sure that similar desired results will follow the reorganization of the extension work. This reorganization has had the careful study of the Assistant Secretary for a year past, and the final plan submitted is the result of that study. When put into effect, as we hope it may be, it will result in considerable saving of money, but, what is far more important, will greatly increase the effectiveness of the extension workers and the quality of the extension work.

Respectfully,

HENRY C. WALLACE,
*Secretary of Agriculture.*

## FUNDS OF THE DEPARTMENT.

The net cost to the Federal Government of the regular activities of the department during the fiscal year 1922 was approximately $34,000,000, as indicated by the following table:

### FEDERAL FUNDS FOR REGULAR WORK OF THE DEPARTMENT.

| | |
|---|---|
| Agricultural appropriation act, 1922 (exclusive of appropriations made direct to States for research work under the Hatch and Adams Acts and for extension work under the Smith-Lever Act; appropriations for farmers' seed-grain loans, for the acquisition of lands by the National Forest Reservation Commission, and for a study of short-time rural credits by a congressional joint committee; and immediately available appropriations expended during 1921) | $30, 409, 643. 00 |
| Agricultural appropriation act, 1923, immediately available funds expended during 1922 | 35, 982. 00 |
| Deficiency appropriation acts (Aug. 24, 1921, Dec. 15, 1921, and Mar. 20, 1922) | 1, 627, 875. 00 |
| Permanent annual appropriation for meat inspection (act of June 30, 1906) | 3, 000, 000. 00 |
| Protection of lands involved in Oregon and California Railroad forfeiture suits (sundry civil appropriation act, 1922, and deficiency appropriation act of July 1, 1922) | 30, 726. 00 |
| Increase of compensation (legislative appropriation act, 1922) | 3, 137, 882. 00 |
| Printing and binding (sundry civil appropriation act, 1922) | 725, 000. 00 |
| Allotment for fixed-nitrogen research (transferred from appropriation placed at disposal of the President by the national defense act of June 3, 1916) | 500, 000. 00 |
| | 39, 467, 108. 00 |
| Excess of unexpended balances and surplus fund, fiscal year 1922, over balances of appropriations from prior years | 14, 450. 00 |
| Actual expenditures from Federal funds for regular work | 39, 452, 658. 00 |
| Less receipts, 1922, deposited in United States Treasury to credit of miscellaneous-receipts fund (see p. 50) | 5, 209, 364. 81 |
| Net cost of regular work | 34, 243, 293. 19 |

Of the total expenditure of $39,000,000 for the regular work of the department, approximately $9,000,000, or 23 per cent, was used for research; $3,000,000, or 8 per cent, for extension; $20,000,000, or 51 per cent, for service and regulatory activities; and $7,000,000, or 18 per cent, for campaigns for the eradication and control of various animal and plant diseases and pests.

### SPECIAL FUNDS FROM RECEIPTS.

In addition to direct Federal appropriations, the following special funds from Forest Service receipts were available for work incident to the department's regular activities:

| | | |
|---|---|---|
| Roads and trails for States (construction and improvement of roads and trails within national forests): | | |
| Amount available from deferred national-forest grazing-fee receipts for fiscal year 1921, collected in fiscal year 1922 (see p. 50) | $161, 236. 34 | |
| Amount available from receipts for fiscal year 1921 | 247, 997. 19 | |
| Balance from receipts in prior years | 369, 284. 19 | |
| | | $778, 517. 72 |

| | | |
|---|---|---|
| Cooperative work, Forest Service (contributions from private sources): | | |
| Receipts for fiscal year 1922 (see p. 50) | $1,378,374.84 | |
| Balance from receipts in prior fiscal years | 570,566.65 | |
| | | $1,948,941.49 |
| Total available | | 2,727,459.21 |
| Actual expenditures from special funds, 1922 | | 2,045,415.38 |
| Unexpended balance, June 30, 1922 (available for expenditure during fiscal year 1923) | | 682,043.83 |

### DIRECT INCOME TO GOVERNMENT IN CONNECTION WITH WORK OF DEPARTMENT OF AGRICULTURE, FISCAL YEAR 1922.

Incident to the department's work during the fiscal year 1922, direct receipts aggregating $8,403,394.05 were covered into the Treasury, and fines were imposed and judgments recovered by the courts amounting to $168,769.36 in connection with the enforcement by the department of the regulatory acts which devolve upon it for administration and execution, as follows:

| | | |
|---|---|---|
| Receipts: | | |
| Deposited to credit of miscellaneous receipts fund— | | |
| From business on the national forests | $4,628,462.42 | |
| From other sources | 580,902.39 | |
| | | $5,209,364.81 |
| Deposited to credit of appropriation for regular work of department | | 324,081.48 |
| Deposited to credit of appropriation administered by but not used in prosecuting regular work of department— | | |
| Reimbursement for cost of distributing surplus war materials to States for use in road-construction work | $323,015.85 | |
| Repayments by farmers of seed-grain loans | 668,742.77 | |
| | | 991,759.62 |
| Deposited to credit of special funds of Forest Service (from business on the national forests) | | 1,878,188.14 |
| Total receipts | | 8,403,394.05 |
| Fines imposed and judgments recovered by the courts in connection with violations of statutes intrusted to Department of Agriculture for enforcement | | 168,769.36 |
| Total direct income to Government resulting from activities of Department of Agriculture | | 8,572,163.41 |

### FEDERAL APPROPRIATIONS ADMINISTERED BY DEPARTMENT, BUT NOT USED FOR ITS REGULAR WORK.

In addition to the $39,452,658 expended by the department for the conduct of its investigative, regulatory, and other routine activities, and the $2,045,415.38 applied to forest road and trail construction and cooperative work from special Forest Service receipt funds, $105,790,311.81 was expended during the fiscal year 1922 from appropriations administered by the department other than those used for the prosecution of its regular work. These funds were provided for the following purposes:

| Items. | Appropriation available, fiscal year 1922. | Expenditure, fiscal year 1922. | Unexpended balance, June 30, 1922. |
|---|---|---|---|
| Extension work in agriculture and home economics: | | | |
| Provided by Smith-Lever Act of May 8, 1914 | $4,080,000.00 | | |
| Supplementary fund provided by agricultural appropriation act for 1922 | 1,500,000.00 | | |
| | 5,580,000.00 | [1] $5,474,050.00 | $105,950.00 |
| Research work of State agricultural experiment stations (provided by agricultural appropriation act for 1922) | 1,440,000.00 | [1] 1,440,000.00 | |
| Federal-aid road construction (provided by acts of July 11, 1916; Feb. 28, 1919; and Nov. 9, 1921): | | | |
| Rural post roads— | | | |
| Appropriated for fiscal year 1922 | 75,000,000.00 | | |
| Balances from prior years | 193,693,858.96 | | |
| | 268,693,858.96 | [2] 89,990,337.53 | [3] 178,703,521.43 |
| Roads and trails within or adjacent to national forests— | | | |
| Appropriated for fiscal year 1922 | 6,000,000.00 | | |
| Balances from prior years | 3,437,473.96 | | |
| | 9,437,473.96 | 3,329,435.52 | [3] 6,108,038.44 |
| Farmers' seed-grain loans: | | | |
| Appropriation provided by special act of Mar. 20, 1922, for loans to farmers in spring of 1922 | 1,500,000.00 | | |
| Appropriation provided by agricultural act of Mar. 3, 1921, for seed loans | 2,000,000.00 | | |
| | 3,500,000.00 | [4] 2,811,966.96 | [5] 688,033.04 |
| Payment from national-forest receipts for benefit of county schools and roads | 1,082,679.99 | 1,082,679.99 | |
| Acquisition of lands by National Forest Reservation Commission for protection of forested watersheds of navigable streams: | | | |
| Provided by agricultural appropriation act for 1922 | 1,000,000.00 | | |
| Balances from prior years | 1,298,371.84 | | |
| | 2,298,371.84 | 839,916.37 | 1,458,455.47 |
| Expenses of National Forest Reservation Commission (provided by act of Mar. 1, 1911) | 25,000.00 | 186.00 | 24,814.00 |
| Refunds to users of national-forest resources of moneys deposited by them in excess of amounts required to secure purchase price of timber, use of lands, etc | 71,086.82 | 71,086.82 | |
| Study of short-time rural credits (provided by agricultural appropriation act of 1922 for use of a special congressional committee) | 5,000.00 | 5,000.00 | |
| Work done by Department of Agriculture for other departments at their request, under authority of sec. 7, fortifications act of May 21, 1920: | | | |
| Allotments from other departments, fiscal year 1922 | 74,800.00 | | |
| Balance of allotment from fiscal year 1921 | 5,842.35 | | |
| | 80,642.35 | 18,167.67 | 62,474.68 |
| Payments during 1922 from balances remaining available of outstanding accounts for expenses incurred in fiscal year 1921 and prior years | 727,484.95 | 727,484.95 | |
| Procuring and disposing of nitrate of soda to farmers (balance of war emergency revolving fund provided by acts of Aug. 10, 1917, Mar. 28, 1918, and Oct. 1, 1918) | 9,936,328.00 | | [6] 9,936,328.00 |
| Stimulating agriculture and facilitating distribution of products—purchase of seed and sale to farmers (balance of war emergency revolving fund provided by acts of Aug. 10, 1917, and Mar. 28, 1918) | 5,680,380.00 | | [7] 5,680,380.00 |
| Total Federal appropriations administered by department but not used for its regular work | 308,558,306.87 | 105,790,311.81 | 202,767,995.06 |

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[1] Paid direct to States by Treasury Department.

[2] Including expenditures from $148,200 available for road-material investigations.

[3] Of these amounts approximately $160,000,000 was obligated through cooperative road-building agreements.

[4] $1,321,038.24 expended in spring of 1921.

[5] Includes $668,742.77 repaid by farmers during fiscal year 1922 (p. 50).

[6] Including $9,500,000 turned into surplus fund Dec. 7, 1921.

[7] Turned into surplus fund Dec. 7, 1921.

*Summary of all appropriations available to the Department of Agriculture for fiscal year 1922.*

| Title of appropriation. | Amount appropriated. | Expenditures to June 30, 1922. | Unexpended balance, June 30, 1922. |
|---|---|---|---|
| Agricultural act for fiscal year 1922 | $36,404,259.00 | $32,002,869.00 | $5,406,765.00 |
| Supplemental appropriations contained in deficiency acts of Aug. 24, 1921, Dec. 15, 1921, Mar. 20, 1922, sundry civil act, and legislative act of Mar. 3, 1921: | | | |
| Suppressing spread of pink bollworm of cotton | 50,000.00 | | |
| Fighting forest fires | 341,000.00 | | |
| Tuberculosis indemnities, Bureau of Animal Industry | 600,000.00 | | |
| Administration of warehouse act | 9,015.00 | | |
| General expenses, Bureau of Soils | 2,860.00 | | |
| Salaries and expenses, wool division | 2,500.00 | | |
| Enforcement of packers and stockyards act | 200,000.00 | 151,238.00 | 48,762.00 |
| Operation of Center Market | 75,000.00 | 30,448.00 | 44,552.00 |
| Enforcement of future trading act | 47,500.00 | 13,884.00 | 33,616.00 |
| White-pine blister rust control | 150,000.00 | 25,337.00 | 124,663.00 |
| Farmers' seed grain loans | 1,500,000.00 | 1,490,929.00 | 9,071.00 |
| Printing and binding | 725,000.00 | 725,000.00 | ................ |
| Increase of compensation | 3,137,882.00 | 3,003,918.00 | 133,964.00 |
| Insect infestation, Forest Service | 150,000.00 | 40,815.00 | 109,185.00 |
| Permanent specific appropriations: | | | |
| Meat inspection (act of June 30, 1906) | 3,000,000.00 | 2,584,842.00 | 415,158.00 |
| Cooperative agricultural extension work (act of May 8, 1914) | 4,080,000.00 | 3,974,050.00 | 105,950.00 |
| Cooperative construction of roads and trails, national forests (act of July 11, 1916) | 1,000,000.00 | ................ | 1,000,000.00 |
| National Forest Reservation Commission (act of Mar. 1, 1911) | 25,000.00 | 186.00 | 24,814.00 |
| Continuing appropriations: | | | |
| Cooperative construction of rural post roads (act of Nov. 9, 1921) | 75,000,000.00 | ................ | 75,000,000.00 |
| Forest highways (act of Nov. 9, 1921) | 2,500,000.00 | 269,873.00 | 2,230,127.00 |
| Forest road development (act of Nov. 9, 1921) | 2,500,000.00 | 524,757.00 | 1,975,243.00 |
| Indefinite appropriations: | | | |
| Refunds to depositors, national-forests fund | 71,086.82 | 71,086.82 | ................ |
| Special funds: | | | |
| Roads and trails for States, national-forests fund | 409,233.53 | 108,685.53 | 300,548.00 |
| Payments to States and Territories, national-forests fund | 1,023,083.81 | 1,023,083.81 | ................ |
| Payments to school funds, Arizona and New Mexico, national-forests fund | 59,596.18 | 59,596.18 | ................ |
| Cooperative work, Forest Service | 1,378,374.84 | 996,879.09 | 381,495.75 |
| Allotnents from other departments: | | | |
| Nitrate plant | 502,600.00 | 226,697.00 | 275,903.00 |
| Protection of lands, California and Oregon Railroad suits | 30,726.85 | 30,614.85 | 112.00 |
| Air service, Army, 1922 | 15,000.00 | 14,740.00 | 260.00 |
| Aviation, Navy, 1922 | 50,000.00 | ................ | 50,000.00 |
| Breeding experimental animals, Army, 1922 | 1,000.00 | 429.00 | 571.00 |
| Investigations for Federal Power Commission | 5,800.00 | ................ | 5,800.00 |
| Manufacture of arms | 400.00 | 400.00 | ................ |
| Unexpended balances of appropriations for prior fiscal years remaining available for expenditure during fiscal year 1922: | | | |
| Appropriations for fiscal year 1920 and prior years | 3,760,431.00 | 1,236,671.00 | [1] 2,523,760.00 |
| Appropriations in agricultural act and supplemental acts for fiscal year 1921 | 5,710,359.00 | 4,547,898.00 | 1,162,461.00 |
| Cooperative work, Forest Service | 570,567.00 | 570,567.00 | ................ |
| Acquisition of lands for protection of forested watersheds of navigable streams | 1,298,371.84 | 609,149.84 | 689,222.00 |
| Procuring and disposing of nitrate of soda | 9,936,327.96 | ................ | [1] 9,936,327.96 |
| Stimulating agriculture and facilitating distribution of products (seeds) | 5,680,380.00 | ................ | [1] 5,680,380.00 |
| Cooperative construction of rural post roads | 193,693,858.96 | 89,990,337.96 | 103,703,521.00 |
| Cooperative construction of roads and trails, national forests | 1,003,175.14 | 866,446.14 | 136,729.00 |
| Federal forest road construction | 2,434,298.82 | 1,668,359.46 | 765,939.36 |
| Roads and trails for States, national forests fund | 369,284.19 | 369,284.19 | ................ |
| Other continuing appropriations | 680,337.62 | 60,302.03 | [1] 620,025.59 |
| Total | 360,184,309.00 | 147,289,385.00 | [1] 212,894,924.00 |

| | |
|---|---|
| Total expenditures, fiscal year 1922 | $147,289,385.00 |
| Revenues received and deposited to miscellaneous receipts during fiscal year | 5,209,364.81 |
| Net cost of all work done by department | 142,080,020.19 |

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[1] Of these balances $17,729,185 was turned into the surplus fund of the Treasury during the year.

## REVIEW OF AGRICULTURAL PRODUCTION AND EXPORTS.

*Acreage of crops in the United States.*

| Crop. | 1922 (preliminary estimate). | 1921 [1] | 1920 | 1919 | 1918 | 1917 | 1916 | 1915 | 1914 | Annual average, 1910–1914. |
|---|---|---|---|---|---|---|---|---|---|---|
| CEREALS. | | | | | | | | | | |
| Corn | 103,234,000 | 103,850,000 | 101,699,000 | 97,170,000 | 101,467,000 | 116,730,000 | 105,296,000 | 106,197,000 | 103,435,000 | 105,240,000 |
| Wheat | 56,770,000 | 62,408,000 | 61,143,000 | 75,694,000 | 59,181,000 | 45,089,000 | 52,316,000 | 60,469,000 | 53,541,000 | 48,953,000 |
| Oats | 41,822,000 | 44,826,000 | 42,491,000 | 40,359,000 | 44,349,000 | 43,553,000 | 41,527,000 | 40,996,000 | 38,412,000 | 38,014,000 |
| Barley | 7,550,000 | 7,240,000 | 7,600,000 | 6,720,000 | 9,740,000 | 8,933,000 | 7,757,000 | 7,148,000 | 7,565,000 | 7,305,000 |
| Rye | 5,118,000 | 4,228,000 | 4,409,000 | 6,307,000 | 6,391,000 | 4,317,000 | 3,213,000 | 3,129,000 | 2,541,000 | 2,305,000 |
| Buckwheat | 707,000 | 671,000 | 701,000 | 700,000 | 1,027,000 | 924,000 | 828,000 | 769,000 | 792,000 | 826,000 |
| Rice | 1,009,000 | 911,000 | 1,336,000 | 1,063,000 | 1,118,550 | 980,900 | 869,000 | 803,000 | 694,000 | 733,000 |
| Grain sorghums | 4,374,000 | 4,652,000 | 5,120,000 | 5,060,000 | 6,036,000 | 5,153 000 | 3,944,000 | 4,153,000 | .......... | .......... |
| Total | 220,614,000 | 228,786,000 | 224,499,000 | 233,073,000 | 232,309,550 | 225,679,900 | 215,750,000 | 223,664,000 | [2] 207,010,000 | [2] 203,376,000 |
| VEGETABLES. | | | | | | | | | | |
| Potatoes | 4,228,000 | 3,815,000 | 3,657,000 | 3,542,000 | 4,295,000 | 4,384,000 | 3,565,000 | 3,734,000 | 3,711,000 | 3,686,000 |
| Sweet potatoes | 1,128,000 | 1,066,000 | 992,000 | 941,000 | 940,000 | 919,000 | 774,000 | 731,000 | 603,000 | 611,000 |
| Total | 5,356,000 | 4,881,000 | 4,649,000 | 4,483,000 | 5,235,000 | 5,303,000 | 4,339,000 | 4,465,000 | 4,314,000 | 4,297,000 |
| Tobacco | 1,763,000 | 1,435,000 | 1,960,000 | 1,951,000 | 1,647,100 | 1,518,000 | 1,413,000 | 1,369,900 | 1,224,000 | 1,209,000 |
| Cotton | 34,852,000 | 30,509,000 | 35,878,000 | 33,566,000 | 36,008,000 | 33,841,000 | 34,985,000 | 31,412,000 | 36,832,000 | 35,330,000 |
| Grand total | 262,585,000 | 265,611,000 | 266,986,000 | 273,073,000 | 275,199,650 | 266,341,900 | 256,487,000 | 260,910,900 | 249,380,000 | 244,212,000 |

[1] Subject to revision in December, 1922.

[2] Excluding grain sorghums.

*Exports of domestic foodstuffs and cotton from the United States.*

[Reports of Bureau of Foreign and Domestic Commerce, United States Department of Commerce.]

| Articles exported. | Annual average, 1910–1914. | Year ending June 30— | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | |
| | | | | | | | | | Amount. | Per cent of 1910–1914. |
| Wheat..............bushels.. | 56,913,228 | 259,642,533 | 173,274,015 | 149,831,427 | 34,118,853 | 178,582,673 | 122,430,724 | 293,267,637 | 208,321,091 | 366.0 |
| Wheat flour.........barrels.. | 10,678,635 | 16,182,765 | 15,520,669 | 11,942,778 | 21,879,951 | 24,181,979 | 21,651,961 | 16,179,956 | 15,796,819 | 147.9 |
| Oats................bushels.. | 8,304,203 | 96,809,551 | 95,918,884 | 88,944,401 | 105,837,309 | 96,360,974 | 33,944,740 | 4,302,346 | 15,767,264 | 189.9 |
| Rye....................do.... | 854,765 | 12,544,880 | 14,532,437 | 13,260,015 | 11,990,123 | 27,540,188 | 37,463,285 | 45,735,052 | 29,903,602 | 3,498.5 |
| Barley.................do.... | 7,895,521 | 26,754,522 | 27,473,160 | 16,381,077 | 26,285,378 | 20,457,781 | 26,571,284 | 20,457,198 | 22,400,393 | 283.7 |
| Corn...................do.... | 39,809,690 | 48,786,291 | 38,217,012 | 64,720,842 | 40,997,827 | 16,687,538 | 14,467,926 | 66,911,093 | 176,409,614 | 443.1 |
| Total, 5 cereals and flour........pounds.. | 8,429,735,124 | 26,567,042,632 | 20,780,577,136 | 19,330,110,628 | 13,951,418,808 | 21,996,905,576 | 16,859,428,924 | 28,195,134,292 | 28,728,753,392 | 340.8 |
| Sugar..................do.... | 70,976,908 | 549,007,411 | 1,630,150,863 | 1,248,908,286 | 576,483,050 | 1,115,865,161 | 1,444,030,665 | 582,698,488 | 2,002,038.450 | 2,820.7 |
| Dairy products: | | | | | | | | | | |
| Butter.............do.... | 4,277,955 | 9,850,704 | 13,487,481 | 26,835,092 | 17,735,966 | 33,739,960 | 27,155,834 | 7,829,255 | 7,511,997 | 175.6 |
| Cheese.............do.... | 4,915,502 | 55,362,917 | 44,391,301 | 66,050,013 | 44,303,076 | 18,791,553 | 19,378,158 | 10,825,603 | 7,471,452 | 152.0 |
| Milk (condensed)..do.... | 15,773,900 | 37,235,627 | 159,577,620 | 259,141,231 | 528,759,232 | 728,740,509 | 710,533,270 | 266,506,031 | 288,628,398 | 1,829.9 |
| Total dairy products .............pounds.. | 24,967,357 | 102,449,248 | 217,459,402 | 352,026,336 | 590,798,274 | 781,272,022 | 757,067,262 | 285,160,889 | 303,611,847 | 1,216.0 |
| Meat and meat products: | | | | | | | | | | |
| Canned beef....pounds.. | 9,392,122 | 75,243,261 | 50,803,765 | 67,536,125 | 97,343,283 | 108,459,660 | 31,133,918 | 10,762,986 | 3,738,486 | 39.8 |
| Fresh beef.........do.... | 29,452,302 | 170,440,934 | 231,214,000 | 197,177,101 | 370,032,900 | 332,205,176 | 153,560,647 | 21,084,203 | 3,996,049 | 13.6 |
| Pickled beef.......do.... | 32,893,172 | 31,874,743 | 38,114,682 | 58,053,667 | 51,467,910 | 45,065,641 | 32,383,501 | 23,312,856 | 26,792,124 | 81.5 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Oleo oil............do.... | 280,224,505 | 80,481,946 | 102,645,914 | 67,110,111 | 56,603,388 | 59,292,122 | 74,529,494 | 106,414,800 | 117,174,260 | 41.8 |
| Oleomargarine.....do.... | 3,268,279 | 5,252,183 | 5,426,221 | 5,651,267 | 6,309,896 | 18,570,400 | 20,952,180 | 6,219,165 | 1,989,421 | 60.9 |
| Stearin............do.... | [1] 3,231,533 | 11,457,907 | 13,062,247 | 12,936,357 | 10,360,030 | 11,537,284 | 22,505,602 | 19,177,311 | 33,017,879 | 1,020.8 |
| Tallow.............do.... | 29,008,749 | 20,239,988 | 16,288,743 | 15,209,369 | 5,014,961 | 16,172,111 | 32,937,026 | 16,843,868 | 27,658,097 | 95.3 |
| Canned pork.......do.... | 4,227,086 | 4,644,418 | 9,610,732 | 5,896,126 | 5,194,468 | 5,273,329 | 3,261,967 | 1,118,967 | 2,263,102 | 53.5 |
| Fresh pork........do.... | 2,023,911 | 3,908,193 | 63,005,524 | 50,435,615 | 21,390,288 | 19,644,388 | 27,224,941 | 57,075,446 | 25,921,083 | 1,280.7 |
| Bacon..............do.... | 182,474,092 | 346.718,227 | 579,808,786 | 667,151,972 | 815,294,424 | 1,238,247,321 | 803,666,861 | 489,298,109 | 350,548,952 | 192.1 |
| Hams and shoulders ..............pounds.. | 166,813,134 | 203,701,114 | 282,208,611 | 266,656,581 | 419,571,869 | 667,240,022 | 275,455,931 | 172,011,676 | 271,641,786 | 162.8 |
| Pickled pork......do.... | 48,274,929 | 45,655,574 | 63,460,713 | 46,992,721 | 33,221,502 | 31,503,997 | 41,643,119 | 33,286,062 | 33,516,746 | 69.4 |
| Lard...............do.... | 474,354,914 | 475,531,908 | 427,011,338 | 444,769,540 | 392,506,355 | 724,771,383 | 587,224,549 | 746,157,246 | 812,379,396 | 171.3 |
| Lard, neutral......do.... | [2] 43,571,550 | 26,021,054 | 34,426,590 | 17,576,240 | 4,258,529 | 17,395,888 | 23,202,027 | 22,544,303 | 19,572,940 | 44.9 |
| Lard, compounds..do.... | 67,318,857 | 69,980,614 | 52,843,311 | 56,359,493 | 31,278,382 | 128,157,327 | 44,195,842 | 42,155,971 | 30,328,176 | 45.1 |
| Sausage, canned.......do.... | 6,369,268 | 1,821,958 | 6,823,085 | 6,294,950 | 5,787,108 | 8,503,580 | 7,034,150 | 4,429,723 | 1,963,548 | 30.8 |
| Sausage, other.........do.... | ............... | 5,183,525 | 8,590,236 | 9,134,471 | 9,239,341 | 9,721,925 | 14,750,963 | 4,926,552 | 7,207,829 | ......... |
| Sausage casings........do.... | 33,644,928 | 30,818,551 | 14,708,893 | 6,118,060 | 6,173,578 | 13,524,093 | 24,379,414 | 29,894,681 | 27,768,795 | 82.5 |
| Total 18 meat products........pounds.. | 1,416,546,331 | 1,608,976,098 | 2,000,053,391 | 2,001,059,766 | 2,344,048,215 | 3,455,285,647 | 2,220,042,132 | 1,806,713,925 | 1,797,478,669 | 126.9 |
| Total of food products mentioned above ...........pounds.. | 9,942,225,720 | 28,827,475,389 | 24,628,240,792 | 22,932,105,016 | 17,462,748,347 | 27,349,328,406 | 21,280,568,983 | 30,869,707,594 | 32,831,882,358 | 330.2 |
| Cotton................do.... | 4,419,802,157 | 4,403,578,499 | 3,084,070,125 | 3,088,080,786 | 2,320,511,665 | 2,762,946,754 | 3,543,743,487 | 2,811,388,710 | 3,358,878,748 | 76.0 |
| Grand total......do.... | 14,362,027,877 | 33,231,053,888 | 27,712,310,917 | 26,020,185,802 | 19,783,260,012 | 30,112,275,160 | 24,824,312,470 | 33,681,096,304 | 36,190,761,106 | 252.0 |

[1] 2-year average.

[2] 4-year average.

*Crop production in the United States.*

[The figures are in round thousands—i. e., 000 omitted.]

| | 1922 preliminary estimate. | 1921[1] | 1920 | 1919 | 1918 | 1917 | 1916 | 1915 | 1914 | Annual average, 1910–1914. |
|---|---|---|---|---|---|---|---|---|---|---|
| CEREALS. | | | | | | | | | | |
| Corn……bushels.. | 2,896,108 | 3,080,372 | 3,208,584 | 2,811,302 | 2,502,665 | 3,065,233 | 2,566,927 | 2,994,793 | 2,672,804 | 2,732,457 |
| Wheat……do.... | 810,123 | 794,893 | 833,027 | 967,979 | 921,438 | 636,655 | 636,318 | 1,025,801 | 891,017 | 728,225 |
| Oats……do.... | 1,229,774 | 1,060,737 | 1,496,281 | 1,184,030 | 1,538,124 | 1,592,740 | 1,251,837 | 1,549,030 | 1,141,060 | 1,157,961 |
| Barley……do.... | 196,431 | 151,181 | 189,332 | 147,608 | 256,225 | 211,759 | 182,309 | 228,851 | 194,953 | 186,208 |
| Rye……do.... | 79,623 | 57,918 | 60,490 | 75,483 | 91,041 | 62,933 | 48,862 | 54,050 | 42,779 | 37,568 |
| Buckwheat……do.... | 13,643 | 14,079 | 13,142 | 14,399 | 16,905 | 16,022 | 11,662 | 15,056 | 16,881 | 17,022 |
| Rice……do.... | 39,159 | 36,515 | 52,066 | 41,985 | 38,606 | 34,739 | 40,861 | 28,947 | 23,649 | 24,378 |
| Grain sorghums……do.... | 81,488 | 115,110 | 137,408 | 130,734 | 73,241 | 61,409 | 53,858 | 114,460 | ………… | ………… |
| | 5,346,349 | 5,310,805 | 5,990,330 | 5,373,520 | 5,438,245 | 5,681,490 | 4,792,634 | 6,010,988 | [2] 4,983,143 | [2] 4,483,819 |
| VEGETABLES. | | | | | | | | | | |
| Potatoes……bushels.. | 433,905 | 346,823 | 403,296 | 322,867 | 411,860 | 442,108 | 286,953 | 359,721 | 409,921 | 360,772 |
| Sweet potatoes……do.... | 110,359 | 98,660 | 103,925 | 97,126 | 87,924 | 83,822 | 70,955 | 75,639 | 56,574 | 57,117 |
| Beans (commercial)……do.... | 13,013 | 9,118 | 9,077 | 13,349 | 17,397 | 16,045 | 10,715 | 10,321 | 11,585 | ………… |
| Onions (commercial)……do.... | 20,309 | 13,757 | 23,525 | 11,398 | 19,336 | 12,376 | 8,562 | 7,664 | (3) | ………… |
| Cabbage (commercial)……tons.. | 1,134 | 687 | 982 | 357 | 498 | 475 | 255 | 671 | (3) | ………… |
| FRUITS. | | | | | | | | | | |
| Peaches……bushels.. | 56,125 | 32.733 | 45,620 | 53,178 | 33,094 | 48,765 | 37,505 | 64,097 | 54,109 | 45,842 |
| Pears……do.... | 17,772 | 10,705 | 16,805 | 15,101 | 13,362 | 13,281 | 11,874 | 11,216 | 12,086 | 11,184 |
| Apples……do.... | 205,539 | 98,097 | 223,677 | 142,086 | 169,625 | 166,749 | 193,905 | 230,011 | 253,200 | 197,898 |
| Cranberries (3 States)……barrels.. | 561 | 373 | 449 | 549 | 352 | 249 | 471 | 441 | 697 | ………… |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MISCELLANEOUS. | | | | | | | | | | |
| Flaxseed....bushels.. | 12,101 | 8,112 | 10,774 | 7,256 | 13,369 | 9,164 | 14,296 | 14,030 | 13,749 | 18,353 |
| Sugar beets....tons.. | 5,000 | 7,782 | 8,538 | 6,421 | 5,949 | 5,980 | 6,228 | 6,511 | 5,585 | 5,391 |
| Tobacco....pounds.. | 1,330,275 | 1,075,418 | 1,582,225 | 1,465,481 | 1,439,071 | 1,249,276 | 1,153,278 | 1,062,237 | 1,034,679 | 991,958 |
| All hay....tons.. | 108,736 | 96,802 | 105,315 | 104,760 | 91,139 | 98,439 | 110,992 | 107,263 | 88,686 | 81,640 |
| Cotton....bales.. | 10,135 | 7,954 | 13,440 | 11,421 | 12,041 | 11,302 | 11,450 | 11,192 | 16,135 | 14,259 |
| Sorghum sirup....gallons.. | 38,225 | 45,554 | 49,505 | 39,413 | 33,387 | 37,472 | 13,668 | 14,823 | 13,551 | 14,974 |
| Peanuts....pounds.. | 691,057 | 816,465 | 841,474 | 783,273 | 1,240,102 | 1,432,581 | 919,028 | ........ | ........ | ........ |
| Broom corn....tons.. | 32 | 35 | 36 | 53 | 62 | 57 | 39 | 52 | ........ | ........ |
| Clover seed....bushels.. | 1,865 | 1,411 | 1,944 | 1,484 | 1,197 | 1,488 | 1,706 | ........ | ........ | ........ |

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[1] Subject to revision, December, 1922.

[2] Excludes grain sorghums.

[3] No estimate.

## PUBLICATIONS OF DEPARTMENT.

During the fiscal year ending June 30, 1922, the department issued publications as summarized in the table below. Of the 33,734,779 copies of bulletins and statistical periodicals printed, 12,235,387 were new and 21,499,392 were reprints of those previously published.

There were 58 new Farmers' Bulletins, of which 1,738,379 copies were printed and of which four-fifths were available for distribution by Congressmen in accordance with law. Farmers' Bulletins contain concise specific statements in nontechnical style of recommendations and directions for procedure in modern agricultural practices. There were 108 new Department Bulletins, of which 577,800 copies were printed. These bulletins contain technical discussions of facts or conditions of importance to agriculture, primarily the results of experimental work of the department. In the Department Circular series 43 new titles were added to the list. These circulars contain information contributions of less technical nature than Department Bulletins and are designed for scientific and limited mailing lists.

*Publications issued by the Department of Agriculture during the fiscal year ending June 30, 1922.*

| Name of publication. | New. | | Reprinted. | | New and reprinted. | |
|---|---|---|---|---|---|---|
| | Number of titles. | Number of copies printed. | Number of titles. | Number of copies printed. | Number of titles. | Number of copies printed. |
| Bulletins, circulars, and yearbook: | | | | | | |
| Farmers' Bulletins | 58 | 1,738,379 | 533 | 21,188,792 | 591 | 22,927,171 |
| Department Bulletins | 108 | 577,800 | 44 | 83,100 | 152 | 660,900 |
| Department Circulars | 43 | 525,000 | 19 | 227,500 | 62 | 752,500 |
| Secretary's Annual Report | 1 | 5,000 | | | 1 | 5,000 |
| Soil Surveys | 31 | 31,000 | | | 31 | 31,000 |
| Yearbook, 1920 | 1 | 20,000 | | | 1 | 20,000 |
| Miscellaneous [1] | | 881,183 | | 2,291,555 | | 3,172,738 |
| Total | [2] 242 | 3,778,362 | 596 | 23,790,947 | [2] 838 | 27,569,309 |
| Statistical and information publications: | | | | | | |
| Experiment Station Record | | 161,700 | | | | 161,700 |
| Official Record [3] | | 438,000 | | | | 438,000 |
| Clip Sheet | | 307,700 | | | | 307,700 |
| Monthly Crop Reporter [4] | | 671,700 | | | | 671,700 |
| Market Reporter [4] | | 766,000 | | | | 766,000 |
| Monthly Weather Review [4] | | 21,875 | | | | 21,875 |
| Weather, Crops, and Markets [5] | | 3,244,000 | | | | 3,244,000 |
| Public Roads [4] | | 23,000 | | | | 23,000 |
| Weekly News Letter [4] | | 2,666,500 | | | | 2,666,500 |
| Special Information Service [4] | | 80,500 | | | | 80,500 |
| Journal of Agricultural Research [4] | | 34,000 | | | | 34,000 |
| Separates, Journal of Agricultural Research | | 42,750 | | | | 42,750 |
| Total | | 8,457,025 | | | | 8,457,025 |
| Grand total | | 12,235,387 | | 23,790,947 | | 36,026,334 |

[1] Includes administrative reports and notices and unnumbered pamphlets.
[2] Not including miscellaneous publications.
[3] Began Jan. 4, 1922.
[4] Discontinued.
[5] Began Jan. 7, 1922.

## LIST OF NEW FARMERS' BULLETINS, DEPARTMENT BULLETINS, AND DEPARTMENT CIRCULARS PUBLISHED DURING FISCAL YEAR.

Following is a list of new Farmers' Bulletins Department Bulletins, and Department Circulars classified by general subject matter. Farmers' Bulletins are indicated by F. B., Department Bulletins by D. B., and Department Circulars by D. C.

| | |
|---|---|
| **Alfalfa:** | |
| Utilization of Alfalfa | F. B. 1229 |
| Garden Flea Hopper in Alfalfa and Its Control | D. B. 964 |
| **Animal pests:** | |
| The Relative Toxicity of Strychnine to the Rat | D. B. 1023 |
| American Moles as Agricultural Pests and as Fur Producers | F. B. 1247 |
| **Apples:** | |
| Northwestern Apple Packing Houses | F. B. 1204 |
| Accounting Records for Sampling Apples by Weight | D. B. 1006 |
| **Beef cattle:** | |
| Beef Production in the Corn Belt | F. B. 1218 |
| Wintering and Summer Fattening of Steers in North Carolina | D. B. 954 |
| Relation of Land Tenure to the Use of the Arid Grazing Lands of the Southwestern States | D. B. 1001 |
| Feeding Experiment with Grade Beef Cows Raising Calves | D. B. 1024 |
| Range and Cattle Management during Drought | D. B. 1031 |
| Effects of Winter Rations on Pasture Gains and Calves | D. B. 1042 |
| The Alkali Disease of Live Stock in the Pecos Valley | D. C. 180 |
| **Bees:** | |
| Swarm Control | F. B. 1198 |
| Beekeeping in the Clover Region | F. B. 1215 |
| Heat Production of Honey Bees in Winter | D. B. 988 |
| Occurrence of Diseases of Adult Bees | D. C. 218 |
| **Birds:** | |
| Community Bird Refuges | F. B. 1239 |
| Instructions for Bird Banding | D. C. 170 |
| The Migratory Bird Treaty Act | D. C. 182 |
| The Migratory Bird Treaty Act | D. C. 202 |
| **Blueberries:** | |
| Directions for Blueberry Culture | D. B. 974 |
| **Bottled foods:** | |
| Volume Variations of Bottled Foods | D. B. 1009 |
| **Breeding live stock:** | |
| Principles of Live Stock Breeding | D. B. 905 |
| **Cabbage:** | |
| Seed Treatment and Rainfall in Relation to Control of Cabbage Blackleg | D. B. 1029 |
| **Canning:** | |
| Relation of Initial Temperature to Pressure, Vacuum, and Temperature Changes in the Container during Canning Operations | D. B. 1022 |
| **Citrus fruit:** | |
| The Avocado: Its Insect Enemies and How to Control Them | F. B. 1261 |
| Control of the Argentine Ant in California Citrus Orchards | D. B. 965 |
| The Composition of California Lemons | D. B. 993 |
| The Red Spider of the Avocado | D. B. 1035 |
| Control of the Citrophilus Mealybug | D. B. 1040 |
| A New Feature of Bud Variation in Citrus | D. C. 206 |
| Commercial Control of Citrus Scab | D. C. 215 |
| Some Changes in the Composition of the California Avocado during Growth | D. B. 1073 |

| | | |
|---|---|---|
| **Corn:** | | |
| The Corn Earworm as an Enemy of Vetch | F. B. | 1206 |
| Inheritance of Ramose Inflorescence in Maize | D. B. | 971 |
| Effects of Mutilating the Seeds on the Growth and Development of Corn | D. B. | 1011 |
| Effects of Date of Seeding on Growth, Germination, and Development of Corn | D. B. | 1014 |
| Marketing Broom Corn | D. B. | 1019 |
| Relation of the Character of the Endosperm to the Susceptibility of Dent Corn to Root Rotting | D. B. | 1062 |
| **Corn oil:** | | |
| Preparation of an Edible Oil from Crude Corn Oil | D. B. | 1010 |
| Comparison of Corn Oils Obtained by Expeller and Benzol Extraction Methods | D. B. | 1054 |
| **Cotton:** | | |
| The Boll-Weevil Problem: Methods of Reducing Damages | F. B. | 1262 |
| Composition of Cotton Seed | D. B. | 948 |
| A System of Accounting for Cotton Ginneries | D. B. | 985 |
| Preliminary Manufacture Tests of the Official Standards of the United States for Color of Upland Tinged and Stained Cotton | D. B. | 990 |
| Water Stress Behavior of Pima Cotton, Arizona | D. B. | 1018 |
| Mead Cotton: An Upland Long-Staple Variety, Replacing the Sea-Island | D. B. | 1030 |
| Marketing Cotton Seed for Planting Purposes | D. B. | 1056 |
| Improvement in Cotton Production | D. C. | 200 |
| The Mixing of Cotton Seed by Modern Gin Equipment | D. C. | 205 |
| Dispersion of the Boll Weevil in 1921 | D. C. | 210 |
| **Cranberries:** | | |
| The Relations of Water Raking to the Keeping Quality of Cranberries | D. B. | 960 |
| **Credit:** | | |
| Buying Farms with Land-Bank Loans | D. B. | 968 |
| Farm Mortgage Loans by Banks, Insurance Companies, and other Agencies | D. B. | 1047 |
| Bank Loans to Farmers on Personal and Collateral Security | D. B. | 1048 |
| The Credit Association as an Agency for Rural Short-Time Credits | D. C. | 197 |
| **Crop experiments:** | | |
| Work of the Huntley Reclamation Experiment Farm in 1920 | D. C. | 204 |
| Work of the San Antonio Experiment Farm in 1919 and 1920 | D. C. | 209 |
| **Crop insurance:** | | |
| Crop Insurance: Risks, Losses, and Principles of Protection | D. B. | 1043 |
| **Crop planting and harvesting dates:** | | |
| Seed Time and Harvest | D. C. | 183 |
| **Cucumbers:** | | |
| Nicotine Dust for Control of the Striped Cucumber Beetle | D. C. | 224 |
| **Dairying:** | | |
| Farm Dairy Houses | F. B. | 1214 |
| Manufacture of Cow's Milk Roquefort Cheese | D. B. | 970 |
| Unit Requirements for Producing Milk in Eastern Nebraska | D. B. | 972 |
| Relation of Production to Income from Dairy Cows | D. B. | 1069 |
| **Drugs:** | | |
| Drying Crude Drugs | F. B. | 1231 |
| **Explosives:** | | |
| Use of Explosives in Blasting Stumps | D. C. | 191 |

**Extension work:**

| | |
|---|---|
| Status and Results of Home Demonstration Work North and West, 1920 | D. C. 178 |
| Status and Results of County Agent Work, North and West, 1920 | D. C. 179 |
| Extension Work among Negroes | D. C. 190 |
| Status and Results of Boys' and Girls' Club Work | D. C. 192 |
| Statistics of Cooperative Extension Work, 1921–22 | D. C. 203 |

**Farm equipment:**

| | |
|---|---|
| Manufacture and Sale of Farm Equipment | D. C. 212 |

**Flowers:**

| | |
|---|---|
| Sawflies Injurious to Rose Foliage | F. B. 1252 |
| The Production of the Easter Lily in Northern Climates | D. B. 962 |

**Foods:**

| | |
|---|---|
| Milk and Its Uses in the Home | F. B. 1207 |
| Home Canning of Fruits and Vegetables | F. B. 1211 |
| A Week's Food for an Average Family | F. B. 1228 |
| A Study of the Factors Affecting Temperature Changes in the Container during the Canning of Fruits and Vegetables | D. B. 956 |
| Food Values: How Foods Meet Body Needs | D. B. 975 |
| Manufacture of Potato Chips | D. B. 1055 |
| Studies in the Clarification of Unfermented Fruit Juices | D. B. 1025 |

**Forestry and trees:**

| | |
|---|---|
| Measuring and Marketing Farm Timber | F. B. 1210 |
| Trees for Town and City Streets | F. B. 1208 |
| Planting and Care of Street Trees | F. B. 1209 |
| Insects Injurious to Deciduous Shade Trees and Their Control | F. B. 1169 |
| Slash Pine | F. B. 1256 |
| Investigations of the White-Pine Blister Rust | D. B. 957 |
| The Manufacture of Ethyl Alcohol from Wood Waste | D. B. 983 |
| Pine-Oil and Pine-Distillate Product Emulsions | D. B. 989 |
| Walnut Husk Maggot | D. B. 992 |
| The Distillation of Stumpwood and Logging Waste of Western Yellow Pine | D. B. 1003 |
| Identification of True Mahogany | D. B. 1050 |
| Studies of Certain Fungi of Economic Importance in the Decay of Building Timbers, with Special Reference to the Factors which Favor Their Development and Dissemination | D. B. 1053 |
| The Chaulmoogra Tree and Some Related Species: A Survey Conducted in Siam, Burma, Assam, and Bengal | D. B. 1057 |
| Research Methods in Study of the Forest Environment | D. B. 1059 |
| Sitka Spruce | D. B. 1060 |
| Curculios that Attack the Young Shoots and Fruits of the Walnut and the Hickory | D. B. 1066 |
| Important Forest Trees of the Eastern United States | D. C. 223 |
| Government Forest Work | D. C. 211 |
| Government Forest Work in Utah | D. C. 198 |
| Handbook for Campers in the National Forests in California | D. C. 185 |
| Treatment of Ornamental White Pine Infected with Blister Rust | D. C. 177 |

**Game:**

| | |
|---|---|
| Game Laws for 1921 | F. B. 1235 |
| Game as a National Resource | D. B. 1049 |
| Laws Relating to Fur-bearing Animals, 1921 | F. B. 1238 |

| | | |
|---|---|---|
| Game—Continued. | | |
| Directory of Officials and Organizations Concerned with the Protection of Birds and Game, 1921 | D. C. | 196 |
| Annual Report of the Governor of Alaska on the Alaska Game Law, 1921 | D. C. | 225 |
| **Garden:** | | |
| Permanent Fruit and Vegetable Gardens | F. B. | 1242 |
| **Grain:** | | |
| Crop Rotations and Cultural Methods at Ridgeley, N. Dak | D. B. | 991 |
| Experiments with Cereals on the Belle Fourche Experiment Farm | D. B. | 1039 |
| The Test Weight of Grain | D. B. | 1065 |
| **Goats:** | | |
| The Angora Goat | F. B. | 1203 |
| **Grapes:** | | |
| Insect and Fungous Enemies of the Grape | F. B. | 1220 |
| **Hay:** | | |
| Marketing Hay at Country Points | D. B. | 977 |
| The Weighing of Market Hay | D. B. | 978 |
| Marketing Hay through Terminal Markets | D. B. | 979 |
| Inspection and Grading of Hay | D. B. | 980 |
| **Home and community:** | | |
| Floors and Floor Coverings | F. B. | 1219 |
| Sewage and Sewerage of Farm Homes | F. B. | 1227 |
| Chimneys and Fireplaces: How to Build Them | F. B. | 1230 |
| Red Cedar Chests as Protection against Moths | D. B. | 1051 |
| The Well-Planned Kitchen | D. C. | 189 |
| The Paper Dress Form | D. C. | 207 |
| National Influence of a Single Farm Community | D. B. | 984 |
| **Horse-radish:** | | |
| The European Horse-Radish Worm | D. B. | 996 |
| **Horses:** | | |
| Breeding Morgan Horses at the United States Morgan Horse Farm | D. C. | 199 |
| **Insects:** | | |
| The Green Bug or Spring Grain Aphis | F. B. | 1217 |
| The Chinch Bug and Its Control | F. B. | 1223 |
| Insects Injurious to the Mango in Florida and How to Control Them | F. B. | 1257 |
| Webworms Injurious to Cereal and Forage Crops and Their Control | F. B. | 1258 |
| A Sawfly Injurious to Young Pines | F. B. | 1259 |
| Stored-Grain Pests | F. B. | 1260 |
| Life History of the Codling Moth in the Grand Valley of Colorado | D. B. | 932 |
| Experiment and Suggestions for the Control of the Codling Moth in the Grand Valley of Colorado | D. B. | 959 |
| Results of Work on Blister Beetles in Kansas | D. B. | 967 |
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# REPORTS OF CHIEFS.

# REPORT OF THE CHIEF OF THE WEATHER BUREAU.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
*Washington, September 12, 1922.*

SIR: I have the honor to submit herewith a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1922.

Respectfully,

C. F. MARVIN,
*Chief of Bureau.*

Hon. HENRY C. WALLACE,
*Secretary of Agriculture.*

Another year of progress and growth of the Nation has passed, during which the Weather Bureau has maintained its operations and service in a normal and efficient manner. There is an increasing use made of the advices, warnings, and information supplied by the Weather Bureau to the public and those interested in agriculture, commerce, the industries, and navigation. Use of the Weather Bureau service means preparedness for future conditions and resulting economic benefits which constitute in a high degree the justification for the costs of conducting the work.

The program of the daily routine of service is far from a perfunctory one, founded as it is upon hundreds of twice-daily reports of ever-changing, ever-variable weather conditions and their distribution over a wide extent of territory which, in fact, now includes a great part of the Northern Hemisphere. Alert and intensive mental study of daily weather maps on the part of a corps of many experts is essential to the issue of successful advices, warnings, and information. Under the present unsatisfactory conditions of employment in the Weather Bureau, the conservation and recruiting of its corps of experts trained in this work is a very serious matter. In no way is this more convincingly demonstrated than by the results of the thorough and careful study made by the Bureau of Efficiency of the job schedules of Weather Bureau employees, resulting in the allocation of practically all employees of the bureau to salary grades according to the proposed reclassification, appreciably in advance of the compensation these efficient and deserving employees now receive. It seems appropriate to quote the following passage from my annual report of last year:

> The long-promised and long-delayed reclassification of Government salaries is nowhere more greatly needed or justified than in the Weather Bureau. The imaginary economies in withholding urgently needed increases for properly strengthening and recruiting the personnel are not economies, but sap and

injure the vitality of the organization and are certain to be reflected in future inferiority and inefficiency. Another legislative year should not go by without some concrete congressional enactment making the promised reclassification effective.

The outstanding feature of the past year as regards weather phenomena is undoubtedly the flood conditions. The year ending June 30, 1922, will rank as a great flood year for the entire Mississippi River Basin and others immediately adjacent thereto. Occurring at the time of the practical completion of the levee system and made excessive by nearly simultaneous flood stages in its large tributaries, the 1922 flood in the lower Mississippi River tested the efficiency of the levee method of flood protection in a way which is certain to be of great help to its proponent engineers and possibly will aid critics to show the weaknesses, if any, of such protective schemes.

A number of notable storms, some accompanied by heavy losses, are mentioned in later pages of this report, and still more complete and detailed accounts have been published in the current issues of the Monthly Weather Review, or will appear in separate bulletins.

## FORECAST SERVICE.

A hurricane occurred on September 8 to 15 in the Atlantic, passing near Bermuda on the latter date, and another near Bermuda about the 12th, while a third severe cyclonic storm of tropical character occurred about the same time in the southwest Gulf region and probably caused the torrential rains producing the unprecedented floods in southern Texas of September 9 and 10.

The only hurricane that actually touched continental United States passed over the Florida Peninsula on October 25, 1921, and caused large property damage, mostly from high tides. This storm demonstrated the inestimable value of wireless communication in the hurricane-warning work of the Weather Bureau. It was first detected by a radio report from a ship in the western Caribbean Sea during the afternoon of October 21. Warnings were immediately broadcast to ships in that region. For five days this storm traveled entirely over water areas. Its center, direction of movement, intensity, and rate of progress were determined principally by vessel reports and warnings and advices were radioed four times daily to vessels in the south Atlantic, the Gulf of Mexico, and the Caribbean Sea. The hurricane was approaching the usual course of vessels bound to and from United States and Mexican ports on the Gulf coasts. The observations received from vessels during the progress of the storm clearly indicated that the warnings had been received and heeded. All ships whose courses were in its direction turned back or changed their routes to avoid the hurricane. Only one ship was lost and property amounting to hundreds of thousands of dollars, which could be moved or protected, was saved as a result of the timeliness and accuracy of the warnings.

On June 12, 1922, a tropical disturbance was located in the southwest portion of the Caribbean Sea. It was of moderate intensity but was accompanied by torrential rains in the vicinity of Swan Island. It moved into Honduras and Yucatan, and caused heavy floods in the rivers of Salvador and probably in the adjoining republics. The disturbance passed inland just south of the mouth of the

Rio Grande during the morning of June 16, progressed for some distance up that valley, and was attended by excessive rains which caused the greatest flood on record in the lower Rio Grande. Storm warnings were displayed on the southern Texas coast well in advance of the storm and at the same time advices were issued that heavy rains would occur in that region.

*Ice storm in New England.*—The most disastrous ice or glaze storm in the "memory of the oldest inhabitants" and within the period of official records occurred in New England during the last few days of November, 1921. It was the result of a cyclone that was central over South Carolina on the 27th and a slight barometric depression that apparently formed over the Atlantic a little to the southward of Nantucket during the night of November 26 and 27. The southern storm moved rapidly northeastward, gained great intensity, and on the evening of the 29th its center was off Cape Cod. It caused gales and high tides on the middle Atlantic and New England coasts and heavy precipitation. In parts of New England, especially Massachusetts, rain fell with air temperatures below the freezing point. Heavy snow had preceded the rain. The latter continued for about three days, during many hours of which period the surface temperatures were several degrees below freezing. The rain froze as it fell and coated trees, telegraph and telephone wires, and other objects. While gales occurred near and off the coast the wind in the ice-storm area was not very high, so that the damage was almost entirely due to the weight of the accumulated ice. Telegraph and telephone poles were broken, communication was paralyzed, and electric light plants were put out of commission. Many thousands of trees were ruined and telephone, telegraph, electric light, and railroad companies suffered heavy losses. Some idea of the accumulation of the ice on objects may be gained from the fact that ordinary insulated electric light wires were in many instances ice-coated 2 inches in diameter and weighed about 1.3 pounds to the foot. It required several days to remove the tangle of broken poles and wires and to restore partial transportation and communication services.

*Storm on the Great Lakes.*—A storm of extraordinary severity raged in the Lake region on December 17 and 18, 1921. The wind velocity at Buffalo equaled the highest on record at that station, 96 miles an hour, and the high winds continued for an unusually long period. During the three hours from 9 a. m. to noon it averaged 89.3 miles an hour and 75.6 miles an hour for a period of 12 hours. Timely and adequate warnings were issued, but there was large property damage notwithstanding the warnings and protective measures that were taken. Sixty-two vessels loaded with grain were anchored in the breakwater harbor at Buffalo but the high winds tore 27 of them from their moorings and swept them onto the beach. The Buffalo Commercial, in an editorial comment on the storm, said:

> It is unlikely that there has been in years a storm of such sustained fury. That there was no greater damage to shipping is due, of course, to the fact that there was ample warning given by the Weather Bureau.

*Heavy snowstorm.*—One of the heaviest falls of snow on record in some of the Atlantic Coast States occurred during January 27, 28, and 29, 1922. The heavy snowfall was due to a storm that first appeared south of Florida on the 26th and moved up the coast. Its movement north of Cape Hatteras was extremely slow. It was almost stationary for more than 24 hours. In the eastern portions of some of the Middle Atlantic States snow fell continuously for about 36 hours. Snow was especially deep in portions of North Carolina, Virginia, the District of Columbia, Maryland, eastern Pennsylvania, and New Jersey. At Washington, D. C., the official measurement was 28 inches, 8 inches more than the previous record, which latter was during the memorable storm of February 11 to 13, 1899. However, there was an important difference between the storms of 1899 and 1922. In 1899 the snow was accompanied by extremely low temperatures (a minimum of 15° below zero was recorded in Washington) while in the 1922 storm the temperature was only slightly below freezing. On the evening of January 28, while snow was still falling, the roof of the Knickerbocker Theater in Washington collapsed while a performance was in progress, killing 97 people and seriously injuring many others.

*Severe squall in New York.*—Squalls of a severity unequaled for many years occurred at several places on the Middle Atlantic and New England coasts during the afternoon of June 11, 1922. They were the result of a cyclone of marked intensity which was central over Lake Ontario on the morning of that day. The squalls attained greatest violence in the vicinity of New York City. Much property damage was caused by the high winds and many persons who were out in small pleasure-craft were drowned. Unfortunately the squall occurred on a Sunday afternoon when large numbers of pleasure boats were in use. On the morning of June 11 small-craft warnings were ordered for the entire Atlantic coast north of Chesapeake Bay and advices issued that squalls would occur during that afternoon and night. Commenting upon the great amount of damage done by Sunday afternoon's storm, and the many fatalities of which it was directly and indirectly the cause, the New York Times remarked that—

> * * * all had been warned, first, by the definite prediction of the Weather Bureau in the morning papers, and, second, by the ominously-black clouds that had been gathering in the west for hours.

*Cold waves, frosts, and miscellaneous warnings.*—Warnings of cold waves in the cattle and stock-raising sections of the country were accurate and beneficial. Warnings of frosts and low temperatures for the benefit of truck and horticultural interests and shippers of perishable products are in increasing demand and use by those who have learned to utilize this important service.

Applications for special forecasts for special functions were numerous and far exceeded any year in the history of the Weather Bureau. During the summer and fall season scarcely a day passed without the forecasters at the five district forecast centers being called on for predictions for lawn parties, State, county, and local fairs, baseball games, social gatherings, etc. Careful consideration is given to all of these requests and in many instances special forecasts in more detail and for a longer period than is covered by the regular daily forecasts are given.

Special forecast service as heretofore was given in connection with airplane and dirigible flights, balloon contests, pigeon races, and for the President's cruises on the *Mayflower*.

*Hurricane service.*—Some additional funds were provided for this work for the fiscal year beginning with July 1, 1922, and plans were developed for their utilization. Stations of the first order will be established at Brownsville, Tex., and Apalachicola, Fla., and a trained observer will be located at Burrwood, La., during the current hurricane season. It is intended to secure more observations from ships and additional tide reports from points along the Gulf. However, there is great need for more observations from the areas in which these disturbances occur, and especially for more reports from ships.

Prior to the opening of the hurricane season two officials connected with the forecast service made a tour of inspection of all the stations on the south Atlantic and Gulf coasts. As a result of this inspection a number of changes providing for greater efficiency in the distribution of the hurricane warnings were put into effect, especially in the western Gulf coast section. Prompt distribution of all warnings and advices concerning hurricanes to all places within 130 miles of the coast having post office, telegraph office, or telephone communication were arranged. Much of this was made possible by the cordial cooperation of the railroad companies and other local agencies.

*Vessel weather reports.*—There is much need for more ship reports, especially from the Gulf of Mexico, the Caribbean Sea, and the Pacific Ocean. Ship observations have become an indispensable factor in forecast work and decidedly so in connection with the issuance of hurricane warnings. This is emphasized by the fact that nine-tenths of the area in which hurricanes occur is water; that the diameter of a hurricane is frequently less than 200 miles, and that many of these storms do not come near land. The Weather Bureau has profited very much by the cordial cooperation of the Shipping Board and several of the large oil companies that operate fleets, from whom, in the aggregate, more weather observations were received from ships at sea than during any previous year.

A portion of the ship reports is furnished by cooperating companies without cost for the observation work, but for the greater part 50 cents an observation is paid. This is insufficient compensation for the time and experience involved in the work, and as a result it has been impossible to interest many ships from which valuable information might be obtained. It is hoped that funds may be provided whereby more adequate payment may be made for ship observations which will go far toward placing this important project on a more efficient and satisfactory basis.

*Forecasts in aid of aviation.*—The activities in the aid of aviation materially increased during the year. Daily forecasts covering 14 zones into which the country is divided were issued regularly and furnished to Army, Navy, and Post Office officials and to the flying fields. In addition, arrangements were made during the year for broadcasting upper-air forecasts for all the zones, except two, from naval radio stations.

Separate and more detailed forecasts were begun in January, 1922, at the request of the Air Service of the Army for the three air routes from Washington to Norfolk, Va., to Long Island, N. Y., and to Dayton, Ohio. They are issued twice daily and contain advices as to weather conditions to be encountered from the surface up to 5,000 feet. These forecasts also are published in morning newspapers in Washington and in Dayton. The requests for special forecasts and weather information from individual aviators before beginning flights have largely increased. This latter information for the most part is supplied by the forecasters by telephone directly to the fliers.

Important and extensive cooperative arrangements between the Air Service and the Weather Bureau were established during the year for the purpose of bringing the aviators of the former service and Weather Bureau officials in the field into closer contact to the end that forecasts, warnings, and weather information may be made of the greatest possible benefit to Army aviators. This plan involves the visits by Air Service aviators to the field stations of the Weather Bureau for the purpose of personal acquaintanceship, the discussion of weather conditions peculiar to the various sections of the country over which flights are made, the acquiring of knowledge of the facilities at each station, for the furnishing of forecasts and information desired by aviators, and the perfecting of details for the securing of such information promptly and whenever required.

The Weather Bureau collects at its field stations twice-daily observations of weather from all parts of the country at 8 a. m. and 8 p. m., seventy-fifth meridian time. Each of the Air Service fields calls the nearest Weather Bureau station by telephone every morning and evening when flying operations are being carried out for the purpose of obtaining the weather forecasts and reports. Fliers when away from their stations are authorized to telegraph or telephone any Weather Bureau station at any time for information as to prevailing and expected weather conditions in a particular section and to receive a prepaid reply. This feature of the service is designed to enable fliers who for any reason are forced to land at other than regular flying fields to secure all possible information which will enable them to avoid danger in returning to their home stations or in reaching their destinations.

Knowledge of the science of meteorology is an important adjunct to expert flying and a part of the cooperation between the two services includes the delivery of lectures by meteorologists of the Weather Bureau to Air Service aviators on the general work of the weather service, the climatology of various sections of the country, air currents, the physics of the air, and on other meteorological subjects pertinent to aviation. Already a number of these lectures have been delivered and plans are being developed for a material extension of this work.

Circulars announcing the details of the cooperation were issued to all field stations of the two services, in which the Chief of the Air Service enjoined that the matter is "of most vital importance at the present time in connection with cross-country flying and it is desired that every effort be made to carry out the provisions as outlined."

A similar cooperation exists with the aerological section of the Navy Department. Forecasts and weather reports are furnished with all possible completeness and dispatch to naval bases at which flying operations are conducted. A representative of that service is given desk space and facilities in the forecast room of the Weather Bureau at Washington, where he prepares each morning a weather map synchronously with the charts used for the issuing of the official forecasts of the Weather Bureau. These official forecasts and weather reports are telephoned by him directly from the Weather Bureau office to the naval bases. In this manner the information and advices are transmitted with the last possible delay and with effective results.

Service was rendered for a number of special airplane flights during the year by furnishing detailed forecasts and extra observations at frequent intervals along the route to be followed. One instance of this kind was the journey of a squadron of 12 seaplanes, much of it over land, from Norfolk, Va., to Pensacola, Fla., by way of the Atlantic coast line to Fernandina, Fla., thence overland across the Florida Peninsula to Cedar Keys and from that point to Pensacola. This journey was undertaken in July, and the various steps in the trips were made in accordance with the forecasts and advices furnished by the Weather Bureau. A seaplane can not land with safety on terra firma, and it was of the utmost importance, both to the success of the undertaking and in safeguarding the lives of the aviators, that no unfavorable weather conditions be encountered, especially for the long overland jump from Fernandina to Cedar Keys. The trip was accomplished without a serious mishap and the commander of the squadron in acknowledging the assistance rendered by the forecaster of the Weather Bureau wrote as follows:

> The commander of air squadrons desires to express his appreciation of the excellent cooperation of the Weather Bureau, both of Washington and Jacksonville, in furnishing weather reports to the air squadrons for the recent flight of 12 F-5-L seaplanes across Florida. The safety of the passage undoubtedly was made more certain thereby, as on the receipt of adverse weather reports the passage of 7 planes was delayed two days, during which severe thunderstorms and rain squalls would have been encountered.

### RADIO DISTRIBUTION OF FORECASTS AND WEATHER INFORMATION.

In the annual report for last year it was stated that radio telegraphy had reached a stage where it must be recognized as a potential medium for the dissemination of weather forecasts, warnings, and information to agricultural interests. It became a realization during the past year. Although wireless telegraphy has been an invaluable factor for many years in the collection of observations from ships and in the distribution of storm and hurricane warnings and weather information to vessels at sea, it was used only to a limited extent for interior service because all messages were necessarily transmitted in the telegraphic code of dots and dashes. With the introduction of radiotelephony, which makes it possible for anyone to receive messages in spoken words, the broadcasting of information over the interior has increased enormously. A year ago the daily State forecasts were being broadcast form 12 radio stations, representing only 7 States, and principally by radiotelegraphy. On July 1, 1922, 98 stations in 35 States were daily broadcasting weather forecasts and warnings. Weekly reports on the effect of weather on crops and highways, and other information issued by the Weather Bureau for the public benefit, also are disseminated by many of them. Radiotelephony is now utilized almost exclusively in this work.

The Weather Bureau does not own or operate any wireless equipment. The radio distribution work is accomplished through plants operated by other Government agencies, by corporations and by private individuals, and without expense to the Weather Bureau. An exclusive wave length of 485 meters has been assigned by the Bureau of Navigation, Department of Commerce, for the broadcasting of weather forecasts and market reports. No station can use this wave length unless specifically licensed to do so. In order that unnecessary crowding of the air and interference with schedules may be avoided licenses are granted to only two stations in any city or community. This necessarily eliminates a considerable number of broadcasting stations that otherwise would gladly cooperate in the work. On July 1, 1922, there were about 400 licensed broadcasting stations in the United States. Therefore, about 25 per cent of all the licensed broadcasting stations in the country are already engaged in rendering valuable distribution service to the public. A considerable portion of the remainder would cooperate if sufficient funds were available to provide them with the forecasts and warnings.

The entire project has involved the Weather Bureau in very little cost. For the most part the broadcasting stations are located in or near cities where first-order meteorological stations are maintained. The information to be broadcast is supplied to them by telephone without additional expense. Offers of cooperation by many broadcasting stations have been reluctantly declined because of the expense involved in the telegraphing or telephoning the forecasts and warnings to them. The service could be placed on a much higher basis of efficiency and materially extended if funds were available for the telegraphing of the forecasts, warnings and information to radio stations not now included in the system and for additional employees which would be required in the work.

The great value of radiotelephony as a means for disseminating weather forecasts and warnings to the people already has been demonstrated. Its future usefulness can not be estimated. The Weather Bureau was organized by Congress for the benefit of "agriculture, commerce, and navigation." Heretofore, a large portion of the farmers of the country were so located that they could not be supplied by means of newspapers, telegraph, etc., with the daily forecasts and warnings in time to be of service to them. The extension of telephone lines into rural communities overcame only a part of this difficulty. Radiotelegraphy was of slight help and necessitated learning the telegraphic code. The marvelous advance in radiotelephony has entirely changed this situation. It requires only a limited equipment to receive radiotelephone messages. Thousands of farmers installed such receiving apparatus during the past year and are now obtaining the weather forecasts and warnings, which are so important to their operations, as promptly and effectively as the business interests in urban communities. A great future increase is inevitable.

Another important accomplishment in radio work during the year was the inauguration of a program of broadcasting daily, Sundays and holidays included, of the regular twice-daily forecasts, cold wave, frost, and other warnings and information issued for the States comprised in the Washington and Chicago forecast districts. On Wednesday during April to November, inclusive, a summary of weather conditions as they affected crops during the preceding week also is included. These disseminations are made from the naval radio stations at Arlington, Va., and Great Lakes, Ill., respectively. This service began June 20, 1922, for the Chicago district and on June 26, 1922, for the Washington district. Radiotelegraphy and high wave-lengths are utilized for these disseminations as telegraphy is more reliable than telephony for long-range transmissions. All the States included in the two districts are within the range of the naval radio stations at Arlington and Great Lakes. Radio receiving stations that are equipped for high wavelength receptions receive direct service thereby. Local radiophone broadcasting stations, most of which are in charge of operators having the required proficiency in radiotelegraph, also are enabled to secure the forecasts, warnings, etc., for localized radiophone broadcasting.

The primary broadcasting of the State forecasts and summaries from the district forecast centers at Washington and Chicago is an immediate adaptation by the Weather Bureau of plans approved by the interdepartmental radio committee, which contemplates the use of a few high-powered Government radio stations for broadcasting official information by radiotelegraphy for the entire country. Plans are now in formation for beginning the broadcasting about September 1, 1922, of the State forecasts, summaries, etc., for the States in the San Francisco forecast district. It is hoped that similar plans for the remaining districts—New Orleans and Denver—will be effected within a few months, thus bringing all the States into the system.

Material extensions were also made during the year in the radio bulletin service for the special benefit of marine and aviation interests. On March 15, 1922, broadcasting of a major bulletin from Goat Island (near San Francisco) was begun, and localized bulletins from Tatoosh Island, Wash.; North Head, Wash.; Eureka, Calif.; San Pedro, Calif.; and Dutch Harbor, Alaska. On April 15, 1922, service of the same character was inaugurated for the Great Lakes regions, the major bulletins being disseminated from Great Lakes, Ill.; and the local bulletins from Alpena, Mich.; Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio; and Duluth, Minn., replacing a limited broadcasting service previously conducted at those points. The radio broadcasting work on the Great Lakes and the Pacific coast is on the same basis as on the Atlantic and Gulf coasts. The character of the major and the local bulletins were described in the report for 1921. In all of this work the Weather Bureau is indebted to the Director of the Office of Communications of the Navy Department and the officials in charge of the various naval radio stations for cordial and efficient cooperation.

*Exchange of weather reports.*—Meteorology is essentially an international science. Cyclones and anticyclones have no regard for boundary lines or 3-mile limits. Exchange of weather reports among all the nations in the Northern Hemisphere is ncessary for the development of the science and for improvement in forecasting. Navigation of the air, which has advanced to the point where transoceanic and round-the-world flights have been demonstrated as practicable, has emphasized the need for the securing of daily reports of prevailing weather conditions from all parts of the world and the issuing of daily international weather charts. Nearly all countries maintain meteorological services and the observations are available. It is largely a question of providing means for prompt and effective transmission and the publishing of the information. This is a project in which cooperation between the various countries is necessary and naturally involves a proportionate payment of the costs. The depressed financial conditions existing throughout the world prevents any serious consideration of such a project at the present time. However, the United States Weather Bureau has been able to arrange for the collecting of a considerable number of foreign reports for its own needs and purposes and at negligible cost.

Prior to the war a few reports were received from Mexico, Europe, Asia, and from the Far East. These were entirely suspended during the war. Arrangements were made for their resumption during the year just ended, with a material increase in the number of reports. There was no interruption to the exchange of reports between the United States and Canada and in the obtaining of observations from Alaska, Cuba, the West Indies, and from Central American countries.

Including the reports obtained under the plans put into operation during the past year, observations are now received daily from 40 stations in Canada; 9 in Alaska; 22 in European countries, embracing England, Spain, Switzerland, Germany, Austria, Czechoslovakia, Poland, Denmark, Norway, Sweden, Iceland, and the Azores; 36 in the West Indies, Cuba, and Central America; 17 in Mexico; and 12 in the Pacific and the Far East, including the Hawaiian Islands, Guam, Midway Island, the Philippines, Japan, and China. These reports are charted and are utilized in connection with the regular forecast and storm-warning work of the bureau.

Arrangements also were made during the year for supplying to the French meteorological service of a daily radiogram containing observations taken at about 40 stations in the United States and a similar message soon will be sent to the meteorological service of the Philippines and Japan. The reports sent to France are broadcast by radio from the Eiffel Tower for the benefit of the European meteorological services within its range. The United States Weather Bureau receives in exchange a daily message by radio, containing reports from European countries. These exchanges are made possible without cost by the cooperation of the Office of Communication of the Navy Department.

The Amundsen polar expedition started from Seattle on June 1, 1922. The exploring ship *Maud* is equipped with radio apparatus and has a scientific officer on board. It is the plan of this expedition to pass through the Bering Straits, reach the farthest point north that is possible, become frozen in the ice, drift therewith for an estimated period of about three years and come into the open sea to the northeastward of Greenland. The ship expects to maintain radio communications with the United States Signal Corps station at Nome, Alaska, for nearly two years. Arrangements were made with the expedition to take twice-daily weather observations and transmit them to the Weather Bureau. A number of observations already have been received. This arrangement will provide valuable observations from the most northern points at which observations have ever been taken and transmitted as a daily program. The ship is also equipped with pilot balloons and it is expected that these observations also will be radiographed daily.

*Orchard spraying service.*—The special forecast service in connection with the orchard spraying activities in the apple-growing sections in the northern part of New York was continued during the past season, and similar work to a limited extent was conducted in localities in Pennsylvania, West Virginia, and Virginia. The forecasts for the New York areas were distributed in previous seasons from the Weather Bureau office at Rochester, but during the past season this work was conducted from Ithaca, where closer cooperation with the State Extension Service and the county agents was obtainable. This arrangement proved more satisfactory and effective work was accomplished.

Damage from frost is not a serious menace to apple growing in northern New York. Serious loss from this cause occurs on an average less than once in 10 years. Scab, a fungous disease, is the worst enemy. It remains dormant so long as the weather is dry. The spores come into activity when moistened and, unless killed by spraying, trees may become infected within 24 hours. The problem is to apply the spray just before a rain because when the rains occur the fungi begin to grow and are killed by the poison in the spray. If the spray is applied and rains do not occur within about three days thereafter the effect of the poison is minimized or lost entirely. There are about 12,000 commercial apple growers in seven counties in New York who are equipped for spraying. At least three applications are necessary each season. It is estimated that the total cost of apple-tree spraying for one season in the seven counties is about $3,500,000. Therefore, accurate and timely forecasts of the occurrence of rains in the spraying season are of great importance to the growers in determining when the spray shall be applied, and the responsibility placed on the Weather Bureau in giving correct information is apparent. If the forecaster fails to predict a rain and spray is not applied the trees become irremediably affected; if rain is predicted and spray is applied but the rains fail to come the effect of the spray is lost entirely, or considerably reduced, and heavy loss results.

The following is quoted from a report made on this special forecast work during the past season by Professor Crosby, of the Department of Entomology, and Professor Horner, plant pathologist of the New York State Extension, which was based on information submitted by field assistants and county agents:

> The special forecasts for the spray service were sent to the following eight counties: Orleans, Monroe, Wayne, Genesee, Onondaga, Chautauqua, and Ulster. They were used constantly by the field assistants in timing their recommendations for spray. In the case of sprays involving fungous diseases these special forecasts are especially important, because it is well known that fungous diseases are vitally affected by the periods of wet weather. Four of the most important counties had a telephone relay system by means of which it was possible to warn the growers quickly when it was time to apply the spray. This system was used throughout the season whenever occasion demanded.

At other times and in counties where the relay system was not used, circular letters and post cards were used to broadcast the information.

The number of fruit growers reached directly by this service was 2,500. It is a well-known fact, however, that nearly every grower who receives the service has at least one neighbor who gets the information from him. This would nearly double the number benefiting by this service.

We feel strongly that these special weather forecasts are of great importance in making the Weather Bureau of real service to our fruit growers and general farmers and that definite provision for the service is essential for getting the full value out of the Weather Bureau.

The New York State Horticultural Society at its summer meeting held at Leroy, N. Y., passed resolutions that "the Government weather forecasts given out in connection with the spray service in New York State has been of great assistance to the fruit growers; we express our appreciation of such service and request its continuance."

The spray forecast work has been conducted as a demonstration of the practicability and value of special forecasts for the benefit of orchardists. The project, although conducted in a limited way, has proved highly successful. It will not be possible, however, to place this project on an adequate and permanent basis and to extend it to other sections, where there is fully as much need therefor, unless additional funds are provided for the work.

## RIVER AND FLOOD SERVICE.

The year of 1922 was unprecedented as to the number and wide distribution of floods, especially with reference to the Illinois Valley, the lower Mississippi and Texas rivers, including the Rio Grande. Stages beyond all previous records were attained in many cases and during the month of April almost every stream east of the Rocky Mountains was in flood, entailing heavy demands upon the Weather Bureau for flood service and information, with corresponding increased expenses for operations.

*The lower Mississippi River floods.*—The river passed the flood stage of 45 feet at Cairo, Ill., on March 16, and did not fall below the flood stage of 35 feet at Baton Rouge, La., until June 12, a total period of 89 days. During the flood the highest stages of record were reached from the mouth of the Arkansas River to the Passes, and had the levees remained intact probably another foot would have been added to the flood crests below Vicksburg, Miss.

There were four important crevasses in the levees, all within the State of Louisiana, and of these the greatest occurred on the right bank near Ferriday, La. The others were at Hamburg, Poydras, and Myrtle Grove, La.

About 13,200 square miles of lands were overflowed, about 4,400 square miles less than in 1912, the deficiency occurring in the Yazoo district.

The total reported losses were about $17,000,000, of which about one-half were in prospective crops. Many losses, especially those to railroads, were unreported.

There was no loss of human life, as the warnings of the floods were several weeks in advance of their occurrence.

*Summary of flood losses.*—The Texas floods of September came with a suddenness that in many localities defied any precautionary measures whatever and caused the loss of 215 lives. Incompletely reported losses of property and crops amount to more than $19,000,000. This amount actually exceeds the total losses caused by the great floods of the following spring in the Mississippi River and its tributaries. The total reported for these latter floods was $17,087,790, and approximately 15,000 square miles of land were overflowed, over 13,000 square miles of which were below the mouth of the Ohio River. The reported grand total of flood losses for the year was about $52,000,000.

In April and May Texas suffered again to the extent of at least $3,000,000, with the highest stages of record in some of the rivers, and still a third time in June, when the great Rio Grande flood did damage to the extent of about $3,000,000, making a total for the year for the State of Texas of about $25,000,000, the major portion of which was in crops, either in hand or prospective.

In April, floods in the Connecticut Valley caused nearly $1,000,000 damage, and the May floods in the Colorado River also proved destructive by reason of the breaking of a levee on the right bank of the river at Hauser Bend, Calif., in the Palo Verde Valley. The crevasse attained a width of 1,300 feet, and the waters flooded 30,000 acres of land, 10,000 of which were under cultivation. The loss and damage amounted to about $1,000,000.

*Destructive local floods.*—An unusual number of destructive local floods occurred in creeks and other small streams, such as those in the State of Washington in December, 1921, at Burlington, Kans., in March, 1922, and in eastern New York, northeastern Pennsylvania, and Wisconsin in June, with estimated total damage of $5,750,000, excluding that in Wisconsin, of which no report of losses was received.

*Flood warnings.*—The flood warnings issued by the Weather Bureau were instrumental in saving property to the reported value of $8,166,500. Growing crops, of course, can not be saved, nor as a rule can houses, roads, bridges, etc., so that the figures given above represent mainly live stock and other portable property, and the statistics received indicate that the losses of property of this kind were very small.

*Summary of operations.*—Natural expansion of river and flood work has been limited to the addition of a few scattered stations and the inauguration at very small cost of flood service on the Platte River. This service is maintained through cooperation with the department of public works of the State of Nebraska, which supplied the gauges and at two stations the gauge readers. Limited extensions were also made in southeastern Missouri.

A new river district was established at San Antonio, Tex., being simply a portion of the old river district of Houston, Tex. The change was made in the interest of efficiency of operation and without additional charge upon the service as a whole. Another change was that of consolidation of the river districts of Iola, Kans., and Fort Smith, Ark., with headquarters at the latter station.

The compilation of the histories of all the river stations, about 500 in number, has been brought to virtual completion and now serves to bring within a very small compass a large mass of valuable material that was unavailable and liable to loss.

*Extensions proposed.*—Increased activities in hydrological engineering and the persistent extension of agricultural and commercial interests demand that the river and flood service keep pace with them. More river-gaging stations and much more intensive measurement of precipitation are needed. These things can be accomplished with a very reasonable increase in appropriations and it is hoped that funds will soon be available. As it is, the service is virtually at a standstill so far as field extensions are concerned. One vital need is that of an engineer who can serve as a field man, inspecting stations, making repairs to equipment, and making surveys for the establishment of permanent benchmarks and other measurements of precision. These surveys are of highest importance in their relation to projects involving water supply for irrigation and power purposes.

*Snow surveys.*—The snow surveys and measurements continued as before. This service is maintained for the purpose of affording each spring to irrigation and hydroelectrical engineers a reasonably accurate forecast of the supply of water that will be available during the coming summer and autumn.

The great importance of such work is obvious, but it requires more intensive local field work in making surveys of snow depths and snow density at the end of each winter, to the end that more accurate forecasts of future water supply may be made. The development of efforts of this character must await further appropriations.

*Wagon Wheel Gap, Colo.*—The experiment station maintained at Wagon Wheel Gap, Colo., has been continued in accordance with the established program. The whole project will be completed within two or three years and the final results communicated as soon as possible thereafter.

## AGRICULTURAL METEOROLOGY.

The usual weekly and daily weather and crop services were continued during the year. The failure of Congress to enact legislation for the continuation of certain publications made it necessary to suspend the issue of the National Weather and Crop Bulletin at the close of November. Beginning with the 1st of January, however, the regular weekly summaries of weather conditions and their effect on vegetation and farm work were resumed, publication being effected through the medium of the new bulletin issued by the Department of Agriculture, known as Weather, Crops, and Markets. The weekly corn and wheat region bulletin was continued at Chicago and a similar bulletin published at New Orleans covering the Cotton Belt, while weekly State summaries have been issued at the various section centers.

*Special services.*—Daily bulletins were published at various stations throughout the principal agricultural sections of the country, giving in tabular form weather conditions prevailing during the 24 hours preceding. These services were maintained in the interests of the cereal, cotton, sugar, and rice production of the country. In addition weekly cattle region bulletins have been issued showing weather conditions over the range areas of Texas, New Mexico, Arizona, Utah, Wyoming, and Nevada. A demand for an extension of this service to other important western grazing areas continued, while the corn and wheat region service should be extended to some important grain States where the lack of funds has prevented extension.

*Fruit-frost service.*—A special appropriation of $9,000 was provided by Congress for the extension of the fruit-frost service of the bureau during the fiscal year, and as a result this service was materially improved. Three special representatives were assigned to this work in the citrus and deciduous fruit districts of the Pacific coast. Active operations were maintained in a number of places in California, at Medford, Oreg., and at Spokane and Yakima, Wash., under the supervision of special employees.

This service was of special value to citrus fruit growers in southern California, where the severest freeze in many years was experienced in January, resulting in enormous loss. Forecasts of minimum temperatures during the period of critical weather conditions were remarkably accurate, and the cooperation of the bureau with the fruit growers was instrumental in saving much fruit that would otherwise have been lost. The appreciation of this service by the citrus interests is indicated by expressions in the following communications received by the bureau:

[From the Pomona Fruit Growers' Exchange.]

Confirming our conversation regarding the value of your service to the citrus industry of this district: we find in the district covered by the Pomona station that there are approximately 7,000 acres equipped for firing and making use of your forecast. The value of the crop in this acreage is fully $2,800,000. There are within this territory about 9,000 acres not prepared to protect against frost. The crop from the unprotected acreage is practically a total loss, besides injury to the trees of a large proportion of this unprotected acreage.

The growers having equipment and using your service burned about 1,380,000 gallons of oil and we consider the information you have furnished has prevented unnecessary burning of a much larger quantity.

We feel that the investigation of frost prevention being carried on by the Weather Bureau is of great importance and we hope there will be nothing to interfere with the continuation of the work.

[From the Fontana Farms Co.]

In reply to your recent inquiry concerning the value of the special service of the Weather Bureau in this section, I would say that growers hereabouts regard the service as invaluable and indispensable.

The action of this company in voting to subscribe a sum of money at the beginning of the frost season to assist in this work may be taken as a reliable indication that such a service as this is needed.

During the recent freeze that caused so much damage to the citrus industry, authentic temperature records taken in this locality were of very great value as an indication of the degree of cold fruit in this locality was subjected to.

We trust that this service may be continued during future years and assure you of our support in your work.

After the close of the frost season in southern California, special bureau representatives rendered successful services in the central and northern Pacific States, particularly in the vicinity of Fresno, in the Santa Clara Valley, Calif., in the Medford district of Oregon, and in the fruit sections of eastern Washington.

Other fruit-frost activities during the year were as follows:

*Ilwaco, Wash.*—The cranberry industry has assumed large proportions near the mouth of the Columbia River. Little interest has heretofore been taken by the growers in the available service of the Weather Bureau, but in the spring of 1922, when heavy frost damage occurred, urgent request for a frost service was made. Action was taken to grant this request in so far as the funds of the bureau would permit.

*Roswell, N. Mex.*—No effort had been made to protect fruit orchards in this district until the present year when many orchards were heated on a number of occasions on receipt of Weather Bureau advices of probable damaging temperatures. Much interest is now shown in the work of frost protection, and practically all the commercial orchards are equipped with frost-fighting devices.

*Yuma, Ariz.*—The temperature survey in the Yuma, Ariz., section that was started a few years ago was enlarged by the establishment of a number of additional stations. This survey is being made primarily in the interests of the citrus-fruit industry, which is assuming considerable proportions in that section.

*Colorado.*—Special services were continued in the Gunnison Valley and in the vicinity of Grand Junction. About 500 acres of orchards are protected in the latter section, and the possibilities of thorough protection by adequate heating were demonstrated at Fruitvale, where an orchard was brought through the cold spell uninjured, notwithstanding the minimum temperature fell to 17° F.

*New Jersey.*—A representative of the Weather Bureau was assigned to New Lisbon during the frost-danger period of the spring of 1922, where a special frost service is maintained in the interest of the cranberry industry in that section.

A fruit-frost service was established during the year at Wichita, Kans. Three special stations were established and frost warnings were distributed to fruit growers over an extended area. In addition, preliminary services were established in Illinois and parts of Florida.

*Cooperation.*—Quite extensive cooperation has been had during the year with the Bureau of Markets and Crop Estimates in the Great Plains project, an investigation which that bureau is carrying forward in the interest of agriculture in the Great Plains States. Other cooperation with the various bureaus of the department was continued.

*Investigations.*—Mathematical studies of the relation between weather and crops was continued as the routine duties of the division permitted. Some very close relations were established between the weather and yields of corn and of oats in some important producing areas, and the importance of the establishment of meteorological stations at agricultural experiment stations becomes more apparent as investigations of this character are continued. Papers published during the year are:

HAMRICK, A. M. "Fruit Frost Work in the Grand Valley of Colorado" (Monthly Weather Review, October, 1921).

KINCER, J. B. "Relation of Climate to the Geographic Distribution of Crops in the United States" (Ecology, April, 1922).

YOUNG, F. D., and ELLISON, E. S. "Notes on 1922 Low Temperatures in California" (California Citrograph, April, 1922).

## STATIONS AND ACCOUNTS DIVISION.

### WEATHER BUREAU QUARTERS AT FIELD STATIONS (OUTSIDE OF WASHINGTON, D. C.).

Since the beginning of the United States Meteorological Service in 1870 it has been a uniform policy to secure quarters for its field stations in Federal buildings, whenever such buildings are suitable for the purpose, and it is practicable to do so. Occasionally where Federal buildings were not available Congress has authorized the erection of special observatory buildings and, in several instances, free accommodations have been secured in State colleges or university buildings. Thus far, in a total of 220 stations, 129 are so situated that no rentals are paid for local offices and accommodations, as follows:

| | | |
|---|---|---|
| Free quarters and accommodations: | | |
| Observatory buildings (owned and controlled by the Weather Bureau) | [1] 46 | |
| State university buildings | 5 | |
| Federal buildings | 78 | |
| Total free of rental | | 129 |
| Rented buildings, etc., owned by individuals or corporations: | | |
| Office buildings | 90 | |
| Buildings with grounds, aerological stations | 6 | |
| Total number of rented buildings partly or wholly occupied | | 96 |
| Total | | [2] 225 |

Under the program of economy in expenditure of appropriations, it has not been possible to keep the 48 buildings owned and controlled by the bureau in thoroughly good condition, and some of these are urgently in need of repairs and repainting for proper preservation. The more urgent cases, however, are now receiving attention.

At San Juan, P. R., in February, 1922, alterations to the building served to add two rooms to provide needed space for assistant observers for the West Indian Section Center work.

The Weather Bureau building at Narragansett Pier, R. I., still continues vacant and in charge of a caretaker. To avoid continual expense for upkeep, this surplus property should be disposed of by sale or otherwise at the earliest practicable date.

After an exhaustive inquiry by a special commission, no practical use has been found by the branches of the Department of Agriculture or other Government departments for the reservation and buildings on the Blue Ridge Mountains, in Loudoun and Clarke Counties, Va., known as Mount Weather. In harmony with suggestion of members of the Committee on Agriculture of the House of Representatives, this bureau has informally but vigorously prosecuted inquiries in regard to a possible purchaser and offer for this property. In this connection we have communicated with and interviewed the owners of properties near the Mount Weather reservation, others who are familiar with the property and its possible utilization and sale; also realtors having a large clientele who are familiar with the property. In addition, supplementing such inquiries at Washington, a representative of the bureau has visited the reservation and the villages and towns in its vicinity for the purpose of bringing the possible sale of the property to the attention of interested parties who might be prevailed upon to make a preliminary proposal or offer for the purchase of this property. Although prosecuting these inquiries diligently throughout the year, no definite proposals have yet been received, and efforts are still being made to secure some preliminary proposal in more or less definite form in regard to the property.

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[1] Not including those at Mount Weather, Va., and Narragansett Pier, R. I.

[2] Five stations have quarters in two buildings each, viz: Cape Henry, Va., 2 Weather Bureau; Cincinnati, Ohio, and Oklahoma, Okla., Weather Bureau and Federal; Columbus, Ohio, 2 rented; and Honolulu, Hawaii, Federal and rented buildings (temporarily).

The buildings and grounds have been inspected by officers of the bureau and repairs necessary for their maintenance in good condition are being made or are planned for in the near future. The property and buildings are in good condition and keepers have been placed in charge of the reservation and buildings for their protection and care. All such expenses of upkeep and necessary repairs amounting to about $2,000 annually constitute an unprofitable charge upon appropriations and no further delay should occur in the enactment of necessary legislation to authorize the sale and disposal of this property substantially as recommended by the commission appointed to report on the disposition thereof.

*Weather Bureau quarters in Federal buildings.*—Upon completion of new Federal buildings at Santa Fe, N. Mex., and Honolulu, Hawaii, Weather Bureau offices at those places were removed from rented quarters, April 1 and May 1, 1922, respectively, thus effecting a saving of $1,920 per annum in rentals heretofore paid, part of rented quarters at Honolulu being retained temporarily for special comparative observations.

By reason of expiration of existing leases June 30, 1922, for rented quarters at Weather Bureau field stations, consideration was given changes affecting in all 23 stations at which $24,179 was paid for rentals during last fiscal year. Of these, Santa Fe, N. Mex., and Honolulu, Hawaii, were moved from rented to free quarters as stated above. At 12 stations no increases were asked in rentals now and heretofore paid, while at the 9 remaining stations the increase demanded was $4,880 on a total rental involved of $9,280, or an average of about 53 per cent. Such exorbitant increase could not be paid with limited funds available, and the situation was met by curtailment of needed space at Atlanta, Ga., and Asheville, N. C., and other compromises. The total increased rental required for next fiscal year for the entire field station service of the Bureau was finally reduced to an increase of $1,077.

*New stations.*—To meet increasing needs for Weather Bureau information, especially during the hurricane season, a first-order station was established June 1, 1922, at Apalachicola, Fla. Quarters were obtained in the Grady Building, No. 200 Water Street.

In July, 1921, in compliance with instructions from Bureau of the Budget, there was set aside the sum of $26,000 from the appropriations for the Weather Bureau, 1922, as a "reserve," to be held, if possible, as a minimum unexpended amount to the end of the fiscal year. This was done, notwithstanding urgent demands for the extension of Weather Bureau activities in various directions and for the maintenance and upkeep of existing stations, with result that a further saving of $6,701.98 was effected, making a total credit for the year about $32,700.

## TELEGRAPH DIVISION.

Telegraphic conditions, both national and local, were more satisfactory during the past year than for several years previous, except for nearly two months, when there was a shortage of force at the central office, due to resignations.

Maintenance by the Western Union Telegraph Co. of the 23 telegraphic circuits has been conducted in a generally excellent manner and comparatively few complaints of defective or delayed service in transmission of special messages have been received. Reception of cable and wireless reports during the six-months' hurricane season beginning June 1, 1921, was not as prompt as was desired, although efforts in various directions were made to effect improvement. More reports from ships were handled than in any preceding year, the increase being largely due to the cooperation extended by the Shipping Board in transmitting reports from many ships twice daily, without cost for wireless tolls, and the gradual extension of general service.

Examination and audit of telegraph, cable, and wireless accounts, all of which is performed by the division operators, was somewhat delayed during the first part of the fiscal year because of the greatly increased work incident to the six-months' hurricane season and of the operator shortage above mentioned. This work was brought up to date, however, during the spring. But little opportunity has been afforded, unfortunately, for such desirable lines of work as revision and improvement of division records, collecting and compiling data for ready reference—largely used by other divisions—investigation of the possibility of more efficient methods of conducting division work, etc.

Contracts with various wireless telegraph companies, with numerous telephone companies, and with several telegraph companies were renewed for the fiscal year 1923 on terms prevailing in former years. Those with the Western Union Telegraph Co. and the New England Telephone & Telegraph Co. are unexecuted at this writing.

A saving of funds to the extent of about $1,000 per annum was effected by rerouting certain forecast and crop messages destined to far-western points.

Assignment of an additional operator last fall has enabled the routine telegraph work to proceed in a much more satisfactory manner than previously, permitting, as it did, placing another operator on the early morning and night forces during the hurricane season and thus facilitating reception of the large volume of cable and wireless business transmitted during this period.

*Weather Bureau telegraph and telephone lines.*—These lines, nine in number, with combined length of approximately 289 miles, including approximately 66 miles of cable and 15 miles of leased wire, worked without serious interruptions and in a generally excellent manner, except the Block Island-Matunuck Beach submarine cable. Over these lines valuable meteorological observations, forecasts and warnings, vessel and wreck reports, and general Government business are transmitted, and five of them carry a volume of commercial business yielding revenue which accrues to the Government.

About 25,000 commercial telegrams were transmitted during the year; about 15,000 Government messages and telephone calls and about 3,000 long-distance telephone calls were handled.

While all these lines are maintained primarily to carry important Weather Bureau reports and warnings where no commercial lines are available for the service, nevertheless the Government derives a significant amount of income from commercial telegrams and telephone calls handled for the public at very small charges.

The following table indicates the receipts for the year:

| | Block Island. | Cape Henry. | Beaver Island. | N. & S. Manitous. | Port Angeles. |
|---|---|---|---|---|---|
| 1921. | | | | | |
| July | $220.24 | $157.77 | $47.75 | $20.06 | $195.98 |
| August | [1] 200.00 | 161.28 | 62.08 | 20.96 | 237.03 |
| September | [1] 31.26 | 145.06 | 45.18 | 11.88 | 185.03 |
| October | 16.44 | 146.95 | 32.15 | 7.60 | 132.91 |
| November | [2] .70 | 171.71 | 76.00 | 7.73 | 124.14 |
| December | (2) | 230.23 | 52.40 | 4.00 | 132.87 |
| 1922. | | | | | |
| January | (2) | 211.69 | 35.92 | 1.75 | 168.74 |
| February | (2) | 95.06 | 33.93 | 2.28 | 144.97 |
| March | (2) | 115.22 | 36.59 | 4.75 | 159.86 |
| April | (2) | 112.89 | 63.95 | 7.72 | 175.63 |
| May | (2) | 85.75 | 70.96 | 10.28 | 168.34 |
| June | 49.11 | 97.03 | 64.64 | 15.71 | [1] 202.32 |
| Totals | 517.75 | 1,730.64 | 621.55 | 114.72 | 2,027.82 |

Grand total, $5,012.48.

[1] Estimated.

[2] Telegraph communication interrupted.

In addition to the above, $600 per annum is received from the New England Telephone & Telegraph Co., Boston, Mass., for rental of two conductors in the Block Island cable.

The cost of maintenance and repair to these lines was $2,500.

*Block Island-Matunuck Beach* (*R. I.*) *section.*—A three-conductor telegraph cable connects the island with the mainland. Two conductors are leased to the New England Telephone & Telegraph Co. for telephone purposes, the third being reserved for telegraph use. This conductor became defective in August, remaining so until June, the Weather Bureau being without sufficient funds to make adequate repairs. During most of this time telegrams were telephoned to and from a telegraph office on the mainland. By cooperation with the Western Union Telegraph Co. repairs were accomplished on June 7, when telegraphing was resumed. For several months in the summer a large number of telegrams are offered for transmission over this cable, the only means of wire communication with the island, a popular summer resort. The interruption above noted seriously interfered with satisfactory conduct of this business, and similar interruptions are liable to occur at any time owing to the age of the cable, which was laid in 1903. It has been repaired numerous times and is subject to gradual deterioration because of electrolysis. The time has come for installation of a commercial cable with adequate facilities to care for the large volume of business now offered. These conditions are recognized by the commercial companies interested, but no action to provide a new cable has been reported to the Weather Bureau.

*Norfolk-Hatteras (Va.-N. C.) section.*—Extensive reconstruction of certain portions of this telegraph line was undertaken with the cooperation of the Coast Guard and the Chesapeake & Potomac Telephone Co., the operating conditions being materially improved thereby. Cost of these repairs approximated $1,000.

The great value of this line to the Government and to private interests is indicated by the following data:

Total number of messages handled by Weather Bureau office, exclusive of all Government and radio business handled by the Navy Department:

| | Sent. | Received. |
|---|---|---|
| Commercial | 5,376 | 5,924 |
| Official messages | 8,264 | 4,702 |
| Total | 13,640 | 10,626 |

Telegraph receipts at Weather Bureau offices:

| | This line. | Other lines. |
|---|---|---|
| Cape Henry, Va | $1,398.28 | $370.86 |
| Hatteras, N. C | 96.99 | 189.39 |
| Manteo, N. C | 235.37 | 407.07 |
| Total | 1,730.64 | 967.32 |

At the Cape Henry office 16,990 vessels and 17 wrecks were reported by telephone and telegraph.

It is proposed to extend reconstruction work to other sections of the line, where badly needed, during this fiscal year.

*Alpena–Thunder Bay–Middle Island (Mich.) section (telephone).*—Some damage was done to these two lines, respectively 15 and 12½ miles in length, by ice storms during the winter and spring. An expenditure of about $1,000 for shortening old poles (set in 1893) is necessary in the near future. Extensive use is made of both lines by the Coast Guard Service, Lighthouse Service, and the Naval Communication Service, and they are of inestimable benefit to marine interests as well as to the Weather Bureau.

*Whitefish Point–Vermilion Point (Mich.) section (telephone)—North and South Manitou Islands–Sleeping Bear Point (Mich.) section (telephone)—Beaver Island–Charlevoix (Mich.) section (telephone).*—These three worked satisfactorily throughout the year.

*Point Reyes–Fairfax (Calif.) section (telephone).*—Satisfactory transmission conditions attended the operation of this line of 37 miles excepting for a total period of 400 hours when it was interrupted by storms. The line is maintained by close cooperation with the Coast Guard which service makes large use of the facilities afforded thereby.

Galvanized iron wire is strung for about 13 miles on poles of the Western Union Telegraph Co. It is contemplated replacing this iron wire with copper wire and to change to poles of the Pacific Telephone & Telegraph Co.

*North Head–Portland (Wash.–Oregon) section (telegraph).*—Interruptions of service, totaling about 344 hours, were frequent but of short duration, caused mostly by improper management of repeaters at Fort Stevens.

Nearly a half mile of the line between North Head and Fort Canby was destroyed by a severe storm December 1. Prompt repairs were accomplished with but slight expense. Telegraphic business consists principally of meteorological and vessel reports, no commercial telegrams being handled.

*Tatoosh-Port Angeles (Wash.) section (telegraph).*—The course of this line of approximately 90 miles along the southern shore of the Strait of Juan de Fuca is mostly through heavy timber and for a large part along a county road. Extensive logging operations in the vicinity of the line have for a number of years past interfered with continuous communication to a considerable extent, necessitating frequent repairs. Heavy storms during the winter are also a fruitful source of trouble. Less than the usual amount of damage resulted during the past year, the cost of upkeep having been approximately $1,000. These interruptions totaled 29 days and 2 hours, 10 days of which was due to prostration of the span wire between Cape Flattery and Tatoosh Island.

Extensive repairs, including changes in the course of the line and some reconstruction work, are contemplated during the present fiscal year, which will require an expenditure of about $1,200.

The line continues to be of benefit to logging, shipping, fishing, and other private interests in addition to its primary use for meteorological purposes. About 11,000 commercial messages were handled during the year, with receipts of approximately $2,100, Government tolls; also 2,400 Government messages and 1,500 long-distance telephone calls.

## AEROLOGICAL INVESTIGATIONS.

*Kite stations.*—Observations with kites were made regularly at Broken Arrow, Okla.; Drexel, Nebr.; Due West, S. C.; Ellendale, N. Dak.; Groesbeck, Tex.; and Royal Center, Ind. Kite flights are made daily, whenever possible, and, in addition when conditions are favorable, continuous series of flights are made for periods of 24 to 36 hours. Records of air pressure, temperature, humidity, and wind are thus obtained.

*Pilot-balloon stations.*—Observations by means of pilot balloons were made at the six kite stations, above listed, and at Burlington, Vt.; Denver, Colo.; Ithaca, N. Y.; Key West, Fla.; Lansing, Mich.; Madison, Wis.; San Francisco, Calif.; San Juan, P. R.; and Washington, D. C. The observations are made twice daily at the six kite stations and at Key West, Fla., and Washington, D. C., and once each day at the remaining stations, and the computed wind conditions at various heights are telegraphed to district forecast centers at Washington, D. C., Chicago, Ill., and San Francisco, Calif., where they form the basis for "Flying Weather" forecasts issued to the military, naval and postal aviation services.

Special observations have been made, when requested, for use in connection with long-distance flights, free-balloon races, etc.

Observations with two theodolites have been continued, whenever opportunity afforded, in order to check the accuracy of the formula for rate of ascent of balloons and the behavior of the balloons themselves at high altitudes. These observations have shown that the revised rate of ascent formula gives extremely reliable results, except when there are pronounced vertical movements in the atmosphere. Even then the error is appreciable only in the lower layers.

*Cooperation.*—Effective cooperation with the Army and Navy meteorological services has been continued throughout the year. Each of these services maintains a number of pilot-balloon stations, whose primary purpose is to furnish data of immediate local interest to aviators at flying fields. These observations are also telegraphed to district forecast centers of the Weather Bureau for use in issuing "Flying Weather" forecasts. They thus supplement, in a very helpful way, the observations made at Weather Bureau aerological stations. In addition to the stations in the United States proper, the Navy maintains one at Santo Domingo, Dominican Republic, and one at Coco Solo, Canal Zone, which, together with those of the Weather Bureau at San Juan, P. R., and Key West, Fla., furnish information of value in connection with the development and movement of hurricanes. A much larger number of stations is necessary, however, to make this service as effective as it should be.

In the autumn of 1921, at the request of the director of the Brazilian meteorological service and in cooperation with a representative of that service, temporarily stationed in Washington, plans for the organization of an aerological service in Brazil, patterned after that in the United States, were outlined and satisfactorily worked out. All necessary equipment was purchased, methods used in this country were studied and adopted, and two trained observers of the Weather Bureau were released, in order that they might be employed by the Brazilian Government to get the service properly inaugurated in that country.

*Central office.*—All observations made at kite and balloon stations, by the Army and Navy as well as by the Weather Bureau, are forwarded to the central office of the Weather Bureau for final reduction and study. Data based upon these observations are furnished in answer to numerous inquiries not only from other government departments, but from commercial aviation concerns as well. In many cases reprints of special discussions and summaries were issued in answer to these requests.

Work has been continued on the preparation of a summary entitled, "An Aerological Survey of the United States." When completed, this will contain the results of all free-air observations made in this country. Part 1, "Results of Observations by Means of Kites," was completed and published during the past year. It contains tables and figures showing monthly, seasonal, and annual values of pressure, temperature, humidity, density, and wind at various heights up to 5 kilometers. It also includes a detailed study of the behavior of free-air winds, classified by months and seasons, by geographic location and according to different wind directions at the surface. Tables and figures are given, showing the frequency and amount of clockwise and counterclockwise turning of winds, the frequency of winds from different directions, the average and extreme velocities encountered, and other data of special interest and value to aviators. This "survey" is confined to those portions of the country east of the Rocky Mountains, since free-air observations farther west are too few for the purpose. Additional stations in the West and a few more in the East than we now have are urgently needed, in order to give complete information for all parts of the country.

At the request of the National Advisory Committee for Aeronautics the preparation of a report on "Standard atmosphere" was undertaken and completed. It has been published by that committee as Report No. 147 and will later be included in the annual report. In it are discussed the need of a standard set of values of pressure, temperature, and density at various altitudes, and the desirability of adopting such values as are most in accord with actual average conditions in order that corrections in individual cases may be as small as possible. To meet this need, so far as the United States is concerned, all free-air observations obtained by means of kites and sounding balloons at several stations in this country near latitude 40° north have been used, and average values of pressure, temperature, and density, based upon these observations, have been determined for summer, winter, and the year, and for all altitudes up to 20,000 meters (65,000 feet). These values have been adopted by the National Advisory Committee for Aeronautics for use as "standard" in this country.

## CLIMATOLOGICAL WORK.

In the main, the regular work of the division was carried forward as usual and all routine matters were well in hand at the close of the year.

The manuscript tables, charts, and text for the several publications of the bureau, weekly, monthly, and annual, were prepared and placed in the hands of the proper officials on the several dates specified. Likewise the thousands of meteorological reports from the regular and cooperative observers have received increased scrutiny to assure the accuracy required in the material placed before the public through the various reports issued by the bureau.

One of the main lines of work in the division, the furnishing of weather information upon written or other requests from all classes of persons and interests requiring such information, has continued with the usual activity, and this, too, has been met in a satisfactory manner, as indicated by the numerous acknowledgments received, which expressed entire satisfaction with the promptness of the information furnished.

*Cooperative work.*—The extensive lines of cooperation by which the Weather Bureau secures valuable observations of weather conditions free of charge, save for the necessary observing outfits, have continued as in the past. Hearty interest in this cooperation is manifested in the thousands of reports carefully prepared day after day, month after month, and for indefinite years, and forwarded promptly to this office and to the State section centers.

The number of these cooperative workers has not materially increased over those of previous years. In fact, effort to reduce the number of those reporting temperature conditions has resulted in keeping that class of stations down to a number thought sufficient for all needs, at the same time arranging for a few new stations at points where temperature observations are considered of value.

On the other hand, effort is being made to increase the number of rainfall measuring stations in sections where local topography causes marked variations in the precipitation at near-by points. It is thought no difficulty will be experienced in securing cooperation along that line at various additional points, and recommendation has been made that appropriation for the purchase of an increased number of gauges be provided for.

*Inspection of cooperative stations.*—The withholding of travel expenditures for economical reasons and because officials could not absent themselves from their stations due to a general shortage of force has prevented the needed inspection of substations to a considerable extent. As a result some deterioration in the character of reports rendered has undoubtedly occurred, due to agencies not readily apparent to the cooperative observers. The most important of these is the tendency of maximum thermometers to become "retreaters," a condition of the thermometers not readily apparent to the observer, but easily detected by the inspector. The increasing number of instruments developing this defect has been commented on by several inspectors. The ultimate cause of this is a falling off in the high quality of maximum thermometers as now produced by manufacturers.

Another serious condition to be guarded against is the constant tendency to an improper exposure of the rain gauge. Faults of this kind are not readily noticed by the observer and are most surely remedied by an inspection.

No expenditure of Government funds will render more valuable returns than those providing for the reasonably frequent inspection of cooperative stations, which furnish such a great volume of most valuable data at no cost except those of forms, instruments, and inspections.

*Climatological publications.*—The material for the Annual Report of the Chief of Bureau and for the Monthly Weather Review has remained practically as during previous years.

The Snow and Ice Bulletin, due to congressional action, was not issued during the first few weeks of the season, but later on it was incorporated in the new department publication, Weather, Crops, and Markets. This soon proved unsatisfactory on account of late issue, and the Snow and Ice Bulletin was therefore issued as an individual publication in nearly the form adopted prior to 1919.

The 45 sections of the Climatological Service are issuing their monthly and annual summaries substantially as last year, save that a few sections have requested permission to increase slightly the number of pages per issue which, for reasons of economy, had been reduced to the lowest possible extent.

The somewhat smaller size of these publications has enabled their printing and distribution at a distinctly earlier date than had been possible for several years past.

The publication of the Alaska Section Summary, which had fallen greatly in arrears, due to certain printing difficulties, was finally brought up as near to date as can be accomplished, considering the conditions attending its preparation.

The Porto Rico section was enlarged to include the new West Indian Climatological Service, with headquarters at San Juan, and considerable delay in printing the monthly issues resulted from the greatly increased number of stations reporting under the new plan of cooperation inaugurated with the various foreign governments in that region.

To meet the needs of engineers and others in California, who are interested in the seasonal precipitation of that State as affecting stream flow and water supply, the section director was authorized to issue as a supplement to the June, 1922, monthly section report, and yearly thereafter, a statement of the monthly precipitation at all stations in that State for the rain year, July, 1921, to June, 1922, inclusive, together with the total for the season. This permits the bringing together in consecutive order the precipitation for the rainy season and enables a more ready means of studying the water problems of that State.

The snowfall bulletins for the 11 mountain States of the West were issued as usual, and somewhat more data were discussed than in previous years, due to increased facilities for obtaining reports.

*Collection and care of meteorological reports.*—All reports containing meteorological data usually forwarded to this division were properly checked, filed, and later prepared for permanent binding.

The reports from the 42 climatological sections of continental United States, about 320 copies for each section, were assembled monthly, temporarily bound at the Government Printing Office, and promptly distributed to foreign weather institutions, libraries, or other public repositories, and to subscribers and others making use of the data they contain.

At the close of the calendar year the permanent supply of these reports for file at stations, consisting of about 140 sets, 5 volumes each, a total of 700 volumes, was assembled, permanently bound, and distributed to the more important stations. Altogether nearly 1,800 separate volumes of reports of all kinds, not including those temporarily bound and distributed each month, were assembled in the division during the year, alphabetically and chronologically arranged, permanently bound, and placed in the proper files.

*Additional work accomplished.*—During the year just closed opportunity was afforded to secure the reprinting of a number of the separate sections of Bulletin W, Summary of the Climatological Data for the United States by sections, many of the sections being entirely exhausted and the editions of others too old to enable their efficient use in answering calls for weather data.

By concerted action between station officials and this division, 26 of the 106 sections were brought down to the end of 1920, with new tables added, and reprinted. Material for 24 additional sections was forwarded to the Government Printing Office and these are in process of completion, and 17 others are now ready, awaiting allotment of necessary funds, while the remaining numbers are in various stages of progress at the respective centers, but will all be ready for printing within a few months.

The preparation of the material for these publications was mainly accomplished at the respective State centers, but the arrangement of the data and checking the various tables and charts devolved upon the clerical force of the division, where, in order to facilitate the work, much of the proofing, revising, and other details were attended to.

*New work.*—The preparation of new normals of the daily maximum, daily minimum, and daily mean temperatures, the details of which were outlined during the preceding year, was carried forward as rapidly as the press of other work permitted. At the end of the year nearly all the stations having 40 or more years of record, some 75 or more, had been practically completed and most of them forwarded to stations for current use.

Considerable progress was made on a proposed new system for maintaining the summarized weather data accumulated at the various State section centers, but on account of prospective world-wide changes in the calendar, now being discussed, it was deemed best to delay any extensive changes at the present time.

The preparation of new normals of daily maximum, daily minimum, and daily means of temperature for the short-record stations of the bureau will be the principal extra work in the division during the present fiscal year.

Loyal support has been given by each member of the division's clerical force.

## PRINTING.

The mailing lists of the bureau have all been revised and brought up to date, resulting in the discontinuance of a number of subscriptions. The demand for Weather Bureau publications from the general public, especially libraries, schools, and colleges, continues to be large. All applications are receiving prompt, careful, and favorable consideration where possible. In case the publications can not be supplied the writer is so advised, and if possible the source from which the publication may be secured.

Under a provision of the sundry civil act of March 4, 1921, Government departments were required to suspend the publication of all periodicals not otherwise specifically authorized by law. The National Weather and Crop Bulletin and the Monthly Weather Review were therefore suspended with the issue of December, 1921. Later the Weather and Crop Bulletin was combined with the Market Reporter and the Monthly Crop Reporter on January 7, 1922, and is now issued weekly throughout the year by the Department of Agriculture under the title, "Weather, Crops, and Markets." The resumption of the issue of the Monthly Weather Review was also authorized.

Under the deficiency bill passed by Congress for printing and binding of the Department of Agriculture, the Weather Bureau was enabled to effect the printing of a considerable amount of back climatological statistics, river stages on the principal rivers of the United States for 1920 and 1921, and the binding of official records. A large amount of this important data had accumulated during the war and since, and the amount of printing and binding accomplished under this appropriation has materially facilitated the work of the bureau.

In accordance with existing regulations the utmost economy was practiced in the issuance of publications and the purchase of paper, ink, and other printing materials. No new or additional machinery or equipment was installed during the year.

## THE MONTHLY WEATHER REVIEW.

The Monthly Weather Review presents under a single cover fairly complete statistics and a discussion of the weather in all parts of the United States and to a lesser extent of the adjacent oceans. This purely statistical record alone is highly prized and extensively used by various marine, commercial, and agricultural interests. The Review also serves as an important aid in the teaching of meteorology in primary and secondary schools; also as a medium of exchange for workers in the field of theoretical as well as applied meteorology. It is now in the fiftieth year of publication, the first issue having appeared in the early part of 1873.

The early numbers were devoted to a résumé of the storms of the month, accompanied by charts showing the path followed by each, with short paragraphs upon the distribution of temperature and precipitation. All of these original features have been carefully preserved and greatly amplified with the passage of years, and many new topics have been added.

The forty-ninth volume contained 745 pages of text and tables and about 120 charts. The fiftieth volume will contain a somewhat smaller number of pages, about the same number of full-size charts, but with the addition of three small inset charts which add considerably to the information graphically presented.

Three contributions to meteorology have been printed during the year as supplements to the Monthly Weather Review, and the manuscript of a fourth is awaiting final action previous to being sent to the Public Printer.

## INVESTIGATIONS IN SEISMOLOGY.

The important work of collecting and publishing earthquake data, begun December 1, 1914, has been continued during the year.

Instrumental records have been obtained by instruments owned and operated by the bureau itself at Washington, D. C., Northfield, Vt., and Chicago, Ill., and similar data secured from various seismic observatories distributed from Panama to Canada and from the Hawaiian Islands to Porto Rico.

The noninstrumental reports rendered by the regular and cooperative observers of the bureau recorded 83 separate earthquakes strong enough to be felt by the unaided senses in the continental United States during the calendar year 1921. The great majority of these resulted in little or no damage, but the widespread shocks which took place in Utah in September, the latter part of October, and first of November caused moderate damage. No important earthquakes occurred in our outlying possessions.

## VOLCANOLOGY.

The funds available for the conduct of observations of the glowing lava beds of the Kilauea Volcano have remained the same as heretofore and have barely sufficed to maintain the program of work as in the past. Some additional investigations by borings supported by funds from the Hawaiian Volcano Association were made during the year.

## LIBRARY.

During the fiscal year 1,130 books and pamphlets were added to the library, the total strength of which is now well over 41,000 volumes. Most of the gaps in periodical publications occasioned by the war have now been filled, the chief exceptions being Russian publications. A nearly exhaustive bibliography of the climatology of South America was published in October. The various catalogues have been kept up to date. One of these, not mentioned in any previous report, is a catalogue of portraits of meteorologists. This has been in progress for several years and is probably the only one of its kind in existence. At least one additional trained assistant is greatly needed, in order to enable the library to undertake important work outside of routine.

## MARINE METEOROLOGY.

The marine meteorological work progressed satisfactorily during the year. A larger amount of data was furnished the Hydrographic Office for publication on the Pilot Charts, and at the same time an increased volume of material of value to marine interests was supplied through publications of the bureau.

During the year arrangements were perfected for an interchange of marine reports with the French meteorological service.

The amount of data furnished for use in admiralty cases was about the same as in previous years.

It was possible near the end of the year to augment the force engaged on the marine work at Washington, where a reduction had been necessary during the preceding year. A further increase of this force is needed to make greater use of the material now being reported by observers, and which supplies the fullest record we have of detailed weather conditions over the Northern Hemisphere.

The volume of reports reaching the bureau still reflects the depressed state of shipping, but shows, nevertheless, the continued interest of seamen in the marine meteorological work.

Reference to the increasing use of radio at sea and its influence on the transmission of weather information will be found elsewhere.

## INSTRUMENT DIVISION.

The maintenance of the instrumental and storm warning equipment of the Weather Bureau, which has an estimated value of $700,000, together with the purchase of necessary new equipment, has been accomplished at an expense of about $26,000. Station officials have cooperated with the division by making diligent effort to keep down expenses without permitting the equipment to deteriorate.

The major portion of the work of repairing instruments, including the rebuilding of special thermographs for fruit-frost investigations, has been performed in the instrument shop, and important progress has been made in the development of new forms of apparatus and instruments.

A new form of solar radiation receiver, utilizing the principle of thermo junctions, was worked out with the joint efforts of several members of the technical staff of the bureau and is now being successfully used in recording solar radiation intensities.

The evaporation program inaugurated in 1916 has been continued. Regular reports are being rendered by 47 stations, and the results are published in the State Section Reports. An annual summary for all stations appears in the statistical section of the annual report of the Chief of the Weather Bureau.

Investigations of the relation between anemometer cup movement and actual wind velocity, begun more than 20 years ago by Prof. C. F. Marvin and limited in scope at that time by the difficulty of obtaining high velocities, have been resumed, and as a result the relations are now known up to 113 miles an hour actual velocity. This investigation has been conducted jointly by Messrs. Fergusson and Covert of the instrument division, using the wind tunnel of the Bureau of Standards, which was primarily constructed for the study of problems in aviation, and in which high velocities under control are easily produced. Many other forms of anemometers, different sizes of cups, and lengths of arms, were also made subjects of experiment, with a view to the early design of an anemometer to record true wind velocities, and the preparation of corrections applicable to the records of the Weather Bureau, which are all on a uniform basis of indicated velocities.

*Exhibits.*—An exhibit to show the activities of the Weather Bureau has been prepared for the Brazilian Centennial Exposition, also three self-demonstrating exhibits and one instrumental exhibit to accompany the Government exhibits sent over circuits routed to State fairs in the United States. This work is carried on cooperatively with the Office of Exhibits.

As a result of the wide distribution of Farmers' Bulletin No. 842, Modern Methods of Protection Against Lightning, the Weather Bureau is being called upon with increasing frequency to answer letters of inquiry in regard to methods to be used in particular instances. R. N. Covert has been named Weather Bureau representative on a committee to formulate a code whose purpose is to specify safe practice in lightning protective measures.

## INVESTIGATIONS IN SOLAR RADIATION.

Continuous registration of the quantity of heat received from the sun at the surface of the earth from day to day has been maintained at Washington, D. C., since 1909; at Madison, Wis., since 1911; and at Lincoln, Nebr., since 1915. In addition, on clear days the intensity of direct solar radiation has been measured at the above stations and also at Santa Fe, N. Mex. At the latter station these measurements were discontinued at the end of March, 1922, when the Weather Bureau office was moved to the new Federal building, which does not afford suitable exposure for pyrheliometers; and at Lincoln, Nebr., the registration of the heat energy received from the sun has been discontinued temporarily on account of a defect in the recording pyrheliometer. It is expected that the early completion of a recording pyrheliometer of improved design will make it possible to replace this defective instrument in the near future.

In addition to heat measurements, the intensity of direct sunlight and of diffuse skylight has been measured on almost every day at

Washington during 12 months ending with April 6, 1922, except that for about four weeks in July and August, 1921, and for a like period in January, 1922, the measurements were made at Chicago, Ill.

From the sky brightness measurements thus obtained charts have been prepared showing the resulting illumination on vertical surfaces, such as the walls of buildings, facing the eight principal points of the compass, for each hour of each day throughout the year for latitude 42° north, with the sky free from clouds and also completely covered with clouds. The charts are based on the measurements made in practically smoke-free atmosphere in a suburb of Washington, but the percentage of diminution in illumination resulting from a smoke cloud such as usually prevails at Chicago has been determined.

Even with skies entirely free from clouds the brightness and the resulting illumination may vary by as much as 50 per cent from the mean value represented by the charts. This is due principally to the presence of haze or dust in the atmosphere to a greater or less degree. A clear blue sky, which is rare at Washington, is dark as compared with a white, hazy sky. Thin clouds increase the brightness of the sky markedly, and especially in the vicinity of the zenith.

A preliminary report on the sky brightness measurements has been published in the Monthly Weather Review, and also in the Transactions of the Illuminating Engineering Society. A more complete report is now in preparation.

These results are of practical importance to illuminating engineers and others having to do with questions of natural lighting, especially as applied to school rooms, office buildings, and industrial plants.

There yet remain to be considered the effect upon interior illumination of substituting for skylight the daylight reflected from the walls of neighboring buildings, and, also, the interior illumination from skylight when the so-called saw-tooth roof construction is employed. It is hoped to solve these two problems during the coming year.

It is also the expectation to take part in an international investigation of the dust content of the atmosphere that has been planned by the meteorological section of the International Geodetic and Geophysical Union.

The official in charge of solar radiation investigations took advantage of a trip to Europe as a delegate to the International Institute of Agriculture and to the International Geodetic and Geophysical Union, both meeting in Rome in May, 1922, to consult with European meteorologists on various topics, more particularly those relating to solar radiation studies.

# REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

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United States Department of Agriculture,
Bureau of Animal Industry,
*Washington, D. C., September 12, 1922.*

Sir: I have the honor to transmit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1922.

Respectfully,

J. R. Mohler,
*Chief of Bureau.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

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## ACTIVITIES OF SPECIAL PROMINENCE.

### PROGRESS IN CONTROLLING BOVINE TUBERCULOSIS.

Because of the far-reaching effects of bovine tuberculosis on the livestock industry, progress in eradicating this disease is a subject of commanding interest. During the fiscal year covered by this report cooperative Federal-State tuberculosis eradication has given highly encouraging results. Herds accredited as free from the disease increased from 8,201 to 16,216. There was even greater gain in the number of herds tested once without showing reactors, the number being 161.533 compared with 49,814 for the preceding year.

The support which tuberculosis eradication is receiving from livestock owners may be judged from the length of the waiting list. On June 30, 1922, there were on file unfilled applications for testing 35,239 herds containing more than half a million cattle. These numbers are more than double those of previous years. Few serious obstacles have been encountered and enthusiasm in the campaign for eradicating tuberculosis has steadily increased. The chief problem is to meet the demand for testing with the funds and facilities provided.

#### CONFERENCES FACILITATE WORK.

During the year several conferences of State, Federal, and local authorities were held to discuss and perfect plans for the work. Such problems as technic in making tests, details of planning and conducting testing on an area scale, and scientific developments in the transmission of the disease were prominent topics for discussion. By thus keeping abreast of developments and approved methods, officials in charge of tuberculosis eradication have been able to show progress which admittedly has surpassed expectations.

### EXTENT OF TUBERCULOSIS SHOWN BY COUNTIES.

Through close cooperation of such officials the approximate per cent of tuberculous cattle by counties throughout the United States has been learned. This information, graphically shown on a map, gives a basis for planning future work. Bovine tuberculosis, according to the map, exists in about 46 per cent of the total area of the United States to an extent not over 1 per cent. In a large additional area the infection does not exceed 3 per cent. The remainder has larger proportions of tuberculous cattle, in a few counties more than 25 per cent. Such information will help greatly in stemming the further spread of the disease, especially by directing attention to sources of greatest danger, and the outlook for the complete though gradual eradication from the areas least infected is most encouraging.

### AREA TESTING MEETS WITH FAVOR.

The increasing recognition, both by officials and cattle owners, of the effectiveness of tuberculin testing under the area plan is another encouraging feature of the work. More than 150 counties had either completed or were engaged in area tests at the end of the fiscal year, and nearly 300 additional counties are arranging for testing all the cattle within their boundaries. This is more than a tenfold increase over the preceding year.

Experience has shown that area testing is not only more economical and more warmly received than testing scattered herds, but also that it builds up a very strong sentiment in the locality for maintaining the cattle in the county on a strict tuberculosis-free basis. Area testing also enlists the support of progressive local veterinary practitioners, gives greater confidence in local milk supplies, and facilitates the disposal of reactors found.

### TICK ERADICATION MAKES PROGRESS.

The outstanding development in eradicating cattle-fever ticks from the United States during the year was the active support this work received in Texas. The number of cattle dippings in that State shattered all records since systematic tick eradication started in 1906. During June, the last month of the fiscal year, dippings in Texas exceeded 6,600,000 and about 10,000 vats were in operation in that State. These results were possible largely through cooperation with the bureau by State and local officials and livestock owners.

Territory released from quarantine during the year because of eradication of ticks aggregated 29,563 square miles. This area was in four States—Georgia, Louisiana, North Carolina, and Texas—about three-fourths of the total area released being in Texas.

In some portions of the South the work met temporary reverses through opposition by lawless elements. Numerous vats were dynamited and violence was threatened or used against inspectors enforcing the dipping of cattle in accordance with State law. Through the employment of ex-service men as inspectors and giving them means of protection when necessary, the work has progressed even in such localities. In numerous cases dynamited vats have been rebuilt by the persons who destroyed them when they learned of the necessity for driving cattle long distances to the nearest vats in operation.

### CONTINUED EXCLUSION OF FOREIGN DISEASES.

Quarantine regulations proved effective during the year with the result that no destructive foreign plague affecting livestock gained admittance to the United States. Never in our history has this country been so nearly surrounded by foot-and-mouth disease as in recent years. Its ravages have been reported from most European, Asiatic, and South American countries, but it has thus far been kept outside the barrier of the Federal quarantine stations. Other serious foreign diseases which have been effectively excluded are contagious pleuropneumonia, rinderpest, surra, and Malta fever.

### LIVESTOCK IMPROVEMENT ACTIVITIES.

Of the many varied lines of work conducted by the bureau, few have met with more support from outside sources than the systematic effort to improve domestic animals in the country. This work, popularly known as the "Better Sires—Better Stock" campaign and begun three years ago, developed rapidly during the year. By the close of the fiscal year nearly 8,000 livestock owners had filed statements with the department that they will use good purebred sires exclusively in their livestock breeding operations and for all classes of animals kept. These agreements affect the use of nearly a million head of breeding stock and are certain to have an important effect on coming generations of domestic animals.

State and local officials, breeding associations, and the agricultural press have given practically unanimous support to this constructive work. The figures mentioned showing persons and animals directly associated with the activity are believed to be small compared to those indirectly affected. Leading States in the work are Ohio, Virginia, Nebraska, Washington, and Kentucky.

### UTILITY VALUE OF PUREBRED LIVESTOCK STUDIED.

During the year the bureau made a study of the utility value of purebred livestock and of results to be expected from the use of purebred sires. Based on the experiences of more than 500 persons who were known to be using purebred sires and who kept female stock of varying quality—including purebreds, crossbreds, grades, and scrubs—the results showed a marked superiority in earning power of well-bred over common stock. For all classes of animals the average reported superiority of purebreds over common stock was approximately 40 per cent. Offspring of purebred sires were shown to be practically 50 per cent more valuable than the offspring of nonpurebreds. Besides, the better bred young stock was more readily salable and had greater utility value when kept on the farm. Other related information on the subject was obtained, analyzed, and prepared for publication.

### EXTENSION WORKERS AND COUNTY AGENTS ACTIVE.

The influence of the bureau's efforts to interest livestock owners in improved animals and methods of breeding has been greatly extended by the activities of extension workers in various States. They and county-agent forces have made excellent use of material developed and furnished. Through demonstrations, meetings, exhibits, contests, and other resources at their disposal they have given to the bureau's fundamental data an effective local application.

### BETTER FEEDING OF LIVESTOCK.

A topic related to the improvement of common stock by breeding it to better sires is the opportunity for adding to individual and national welfare by the better feeding of farm animals. The constant demand for information on good feeding methods and the fact that there is room for improvement in this field makes such an activity highly desirable. The problem is largely one of making available in attractive form the existing knowledge on the subject.

### PROGRESS IN FEEDING INVESTIGATIONS.

Recent experiments by the bureau have resulted in new and fundamental knowledge on the feeding of meat animals, particularly cattle and swine. A series of experiments conducted cooperatively with several States shows the influence of winter rations for cattle and calves on their ability to use pasture economically the following season. This investigation has included costs of production as well as gains on various rations.

Inquiry into the causes of soft pork, begun more than a year ago, has been continued. The effect of peanuts and peanut meal has received major consideration, but the effects of other feeds, such as soy beans and rice by-products, likewise have been studied. Developments in this work are resulting in the accumulation of new and useful data. In poultry feeding, experiments show conclusively the importance of animal protein in the ration.

### MEAT IN THE DIET.

With considerable concern the livestock industry has noted a general decline in the consumption of meat in the United States compared with the figures of a decade ago. This fact, combined with the falling off of exports to practically a pre-war basis, has shown the need for close attention to the study of meat in the American diet.

An increased recognition of the nutritive value of meats and the distribution of educational material to counteract unfounded prejudices are activities obviously desirable. Through exhibits and published material, steps in this direction already have been taken.

The bureau likewise has conducted experiments to determine the extent of the beneficial substances known as vitamins in various meats. Results obtained thus far show that pork, especially, is reasonably rich in vitamin B. The study of vitamins in meat is being continued.

Through meat-inspection records as well as from other sources within and out of the department, the bureau has collected information on meat production, consumption, and foreign trade. A publication discussing these subjects, so important to the livestock industry, is in press.

### ANIMAL EXPERIMENTATION BENEFICIAL TO MAN.

In the field of animal-parasite control, experiments with carbon tetrachlorid have given excellent results. Work with this relatively cheap chemical has shown it to possess great effectiveness combined with a large factor of safety for animals treated. New methods of treating animals for parasites and involving the use of carbon tetrachlorid are being developed. So promising is the possibility of the drug that it is attracting favorable attention in the field of human medicine, notably for the treatment of hookworm. Correspondence on this subject and on the progress of the work has been unusually large and is further evidence of the value of animal experimentation having a bearing on human welfare.

### PERSONNEL.

At the beginning of the fiscal year there were 4,137 employees in the service of the bureau. During the year 613 additions were made, 519 by appointment, 27 by transfer from other branches of the Government service, and 67 by reinstatement of former employees. In the same period 509 employees were separated from the service, 182 by resignation, 16 because of death, 23 by transfer to other bureaus or departments, 1 was removed for cause, while other separations numbered 287. At the end of the fiscal year the bureau rolls contained 4,241 names, an increase of 104 during the year. More than one-half of the increase may be accounted for in the intensive work for the eradication of cattle ticks.

### VETERINARY EDUCATION.

No change in the number of accredited veterinary colleges whose graduates are eligible to take the civil-service examinations for positions in the bureau occurred during the year, the number remaining at 16. The graduates of three agricultural colleges with two-year veterinary courses are given credit for work completed in these institutions when entering one of the accredited veterinary colleges. No additions were made to the list of foreign veterinary colleges accredited by the bureau, the number being 14.

The total number of freshmen enrolled in all veterinary colleges for the school year 1921–22 was 169, as compared with 182 during the preceding year, a decrease of 13. The total enrollment was 796, against 965 for the preceding school year. The number of graduates was 171, as compared with 277 in 1921. Nine of the students included in the total enrollment were attending agricultural colleges having two-year veterinary courses and must take additional work at an accredited college before being eligible for bureau positions.

### LITERATURE, EXHIBITS, AND MOTION PICTURES.

The bureau contributed during the year 72 new and revised publications, including 16 Farmers' Bulletins, 11 Department Bulletins, 3 papers for the Yearbook, 13 issues of Service and Regulatory Announcements (including index), 7 articles for the Journal of Agricultural Research, 4 Department Circulars, 11 miscellaneous pamphlets, 6 orders in the nature of regulations, and 1 map. Seventy-one other manuscripts were prepared for outside publication in scientific, agricultural, and other journals. In addition the bureau furnished to the press service of the department 270 articles and items for general publicity.

A series of 10 pictures, of a size suitable for mounting and display, illustrating various species of farm animals of good quality, has been completed. The subjects include dairy and beef cattle, horses, mules, swine, sheep, goats, and poultry. These pictures are intended to show desirable types of livestock in the interests of the campaign for improved breeding.

In cooperation with the department's Office of Exhibits the bureau designed and aided in preparing exhibits for numerous agricultural expositions, fairs, and shows. Special exhibits for the National Dairy Show and the International Live Stock Exposition attracted much attention and favorable comment.

Among new motion pictures prepared during the year in collaboration with the department's motion-picture laboratory was one entitled "Exit Ascaris," depicting in story form the life history of the roundworm of swine and methods of prevention. An earlier film, "Great Dairy Sires and Their Daughters," has proved to be among the most popular in the department's collection. The film on tuberculosis eradication has been a valuable aid in advancing that work.

### REPORTS BY DIVISIONS.

The year's work as conducted by the various divisions of the bureau is presented more fully in the following pages.

## ANIMAL HUSBANDRY DIVISION.

The work of the Animal Husbandry Division, consisting chiefly of research in animal and poultry husbandry, was conducted under the direction of George M. Rommel, chief, up to the end of October, 1921, when his resignation became effective. For the remainder of the fiscal year the activities of the division were in charge of E. W. Sheets, acting chief.

### ANIMAL HUSBANDRY EXPERIMENT FARM.

Numerous improvements were made at the Animal Husbandry Division Experiment Farm, Beltsville, Md. The numbers of live animals remain about the same as in the preceding year. The farm is used as a practical laboratory and proving ground for solving livestock problems.

### ANIMAL GENETICS.

The principal project in animal genetics has been the study of the effects of inbreeding and crossbreeding, using guinea pigs as material. Clear-cut results have been obtained and are presented in three papers, which are in press in two department bulletins.

The study of the theoretical effects of various systems of mating has been continued. A paper is in press describing a method of obtaining a coefficient of inbreeding which is applicable to complex pedigree and which gives an exact measure of the effects to be expected on the Mendelian theory of inbreeding.

An inbreeding experiment with White Leghorn poultry has been begun in cooperation with the poultry office. The primary object is the production of purified strains. Another object is to test the possibility of obtaining superior strains from particular crosses between inbred strains. A somewhat similar project with hogs is under way.

The study of the relative importance of heredity and other factors in the resistance of guinea pigs to tuberculosis has been continued in cooperation with Dr. Paul A. Lewis, of the Henry Phipps Institute of Philadelphia. The new results confirm those previously obtained and put the major conclusions beyond doubt.

A large amount of time has been devoted to the statistical analysis of various questions connected with livestock production. The relations between fluctuations in the quantities and prices of corn, hay, and livestock during 43 years preceding the war have been studied by the methods of multiple correlation and path coefficients based on some 2,400 primary coefficients of correlation. Similar methods are being applied to the statistical analysis of data collected in connection with the investigations relating to range sheep, soft pork, and other subjects.

## BEEF CATTLE INVESTIGATIONS.

Investigations in the production and fattening of beef cattle have been continued in the Appalachian region, the Corn Belt, the Cotton Belt, and the Western and Southwestern range areas. All experimental work is done cooperatively with the respective State agricultural experiment stations. The investigations in the Corn Belt and range areas are carried on in cooperation with the Bureau of Agricultural Economics of the department, as well as with the State stations. Details can not very well be given in a report of this kind, but the results are published in other forms from time to time.

### WINTERING STEERS IN THE APPALACHIAN REGION.

At Lewisburg, W. Va., the final year's work in a three-year experiment in wintering steers was begun December 22, 1921, with six lots of ten 2-year-old steers each, to compare the effects of winter rations on the gains made by them as 3-year-old steers on grass the following summer. Data for three winters and two summers are now available.

### FATTENING STEERS IN THE CORN BELT.

Investigations in Illinois, Indiana, Iowa, Missouri, and Nebraska to determine the basic requirements in feed, labor, and miscellaneous items in fattening beef cattle, planned to cover a period of five years, are now in their fourth year. Approximately 100 feeding records have been taken annually in each of the five States. The total yearly survey involves from 18,000 to 20,000 head of beef cattle. The surveys make it possible to compare the methods and economy of production.

### FEEDING BEEF CATTLE IN THE COTTON BELT.

At the Coastal Plain Experiment Station, McNeill, Miss., a breeding herd of beef cattle is maintained to determine the rate of gains, the seasonal gains, and the grazing season of burned range pasture grazed at the rate of 10 acres per head. Several experiments involving more than 100 head of cattle and a variety of feed combinations and conditions were carried out during the fiscal year.

In an experiment to compare velvet beans in different forms with cottonseed mead for fattening steers, three lots of steers of 10 head each were fed for a period of 98 days.

At Jonesboro, Ark., records are being kept to determine the feed requirements for growing purebred beef cattle. Three lots of 10 cows each have been fed different rations for 126 days and the gains in weight compared.

At the department's Iberia Experiment Farm, Jeanerette, La., silage made from corn, sorghum, soy beans, Japanese cane, sugar cane, and sugar-cane tops, and mixed silages from these crops, are being tested as to their value for fattening steers. The value of adding molasses to rations of silage and cottonseed meal is also being tested. First and second cross Hereford native cows are being crossed with Hereford and Brahman bulls to compare the value of their progeny, both as breeding and feeding stock.

### BREEDING FOR MILKING QUALITY IN BEEF CATTLE.

The 20-year experiment begun September 1, 1915, at Manhattan, Kans., in cooperation with the State agricultural college, to determine to what extent milk production can be developed without sacrificing desirable beef type is being continued with a breeding herd of Shorthorn cattle.

### BEEF PRODUCTION ON THE RANGE.

Surveys similar to those made in the Corn Belt are being made to determine the basic requirements in feed, labor, and miscellaneous items involved in the growing and raising of beef cattle in the Western and Southwestern range States. Work is well under way in Colorado, Kansas, Oklahoma, and Texas.

An extensive survey was made of the production of Brahman cattle in Texas. In addition to the investigation of the herds that are devoted to the production of breeding stock, attention was given to ranching concerns that are using Brahman bulls on native grade Hereford and grade Shorthorn cows, with a view of determining the most desirable crosses and the possible adaptation of Brahman cattle to other than Gulf coast ranges.

A representative of the division was detailed for duty with a special livestock train making a 30-day trip through Mexico in November and December. The train carried consignments of livestock of Texas breeders. Exhibitions were held in eight cities. Livestock conditions were studied with special reference to the supply and possible future demand for breeding stock in Mexico.

### SWINE INVESTIGATIONS.

The principal investigational work with swine is conducted at the bureau's experiment farm, Beltsville, Md., where on June 30, 1922, there were 499 hogs and pigs representing the six principal breeds of swine, together with representative animals of the so-called Piney Woods rooter type and crossbred animals which are used in special breeding experiments. One hundred and fifty-seven swine from this farm were supplied to or exchanged with other stations for experimental work. Among these was a purebred Duroc-Jersey boar which was shipped to the Belle Fourche Experiment Farm, Newell, S. Dak., to head the herd of hogs at that place.

Pigs at Jeanerette, La., are fed on rice and other products and when finished are shipped to the abattoir at Beltsville, Md., where the carcasses are graded and chemical and physical tests are made. Investigations at the stations at McNeill, Miss., Huntley, Mont., and Ardmore, S. Dak., are conducted largely for the purpose of obtaining detailed information regarding the cost of producing feeder pigs and the feasibility of using them to supply the demand in the Corn Belt.

Experiments to determine the effects of lice and worms on the fattening properties of hogs have been continued and are still in progress.

### SLAUGHTER AND CURING TESTS.

Since all animals ultimately pass through the abattoir for final data on experiments in the various projects, a considerable volume of meat is handled in the course of the year. Advantage is taken of opportunities to conduct experiments in the curing of meats and the preparation of meat products. Particularly are these tests made in connection with soft-pork studies and with methods which may be used when applied under ordinary farm conditions.

During the year some work was done on the curing of meats without refrigeration, with a view to producing mild, well-flavored products which will remain sound and sweet throughout a number of months, and thus avoid losses which now occur in curing pork in the South. Standardized recipes for mild and spicy sausage, smoked sausage, headcheese, liver sausage, etc., are being developed.

### SOFT-PORK INVESTIGATIONS.

Research work relating to the soft-pork problem, which was begun in 1919, has been continued and extended. Experiments involving 383 hogs were carried on in cooperation with the State agricultural experiment stations of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Oklahoma, South Carolina, and Texas, and independent experiments with 247 hogs were carried on at the bureau farm at Beltsville, Md., and the Iberia farm at Jeanerette, La., making a total of 630 hogs used in these investigations. The hogs were fed on peanuts, soy beans, rice by-products, and combinations including these and other feeds.

It has been the general conception for years that soft-pork production was limited practically to those States where peanuts were available for use in fattening hogs. It is now known that other feeds and possibly other factors aside from feed are responsible for a certain proportion of the soft hogs produced.

Five hundred and twelve of the hogs were slaughtered at Beltsville, Md., the remaining 118 being slaughtered at Oklahoma, Okla. All carcasses were graded by a committee. The grading was always done after thorough chilling at a temperature of 32° to 38° F. Each carcass was classified into one of four grades, viz, hard, medium, soft, or soft and oily. Chemical tests of samples of fat were made and compared with the committee's grading. The agreement between the committee's grading and the refractive index and iodin number of back fat was found to be quite close, while the melting point of back fat was found to be the poorest chemical indication of the firmness of the fat.

Summarizing the results so far obtained in three years' investigations, it has been shown conclusively that when hogs starting at a weight of approximately 100 pounds are fed on peanuts in the dry lot or grazed in the field for a period of 60 days or more a soft carcass is produced, and that it is impossible to produce a hard carcass by feeding corn and tankage or corn and cottonseed meal to these soft hogs for a subsequent period of 60 days or less. This statement is not meant to discourage in any way the feeding of peanuts to hogs in those sections of the South that are well adapted to the production of this crop. The experimental data compiled by the southern stations indicate very clearly that peanuts are one of the most economical feeds known for hogs and can be fed with profit in many sections of the South, even though soft hogs are discriminated against on the market. Much work remains to be done on certain phases of the soft-pork problem.

### SWINE BREEDING.

To determine the effects of purebred sires in the grading up of common hogs on costs of production and feeding qualities, a series of tests have been begun at Beltsville, Md. The sows include typical Piney Woods rooters from the South and sows of mixed breeding representing at least three or four known crosses. It is the purpose to determine the effect of feed and management apart from breeding, and as thoroughly as possible the effect of breeding apart from feeding and management.

## SHEEP AND GOAT INVESTIGATIONS.

### FARM SHEEP INVESTIGATIONS.

Four main lines of sheep investigations were carried on at the bureau's experiment farm at Beltsville, Md., namely, (1) effects of "flushing" and various other methods of feeding and management upon lamb yields; (2) a practical system of forage grazing; (3) studies in growth by means of weighing lambs weekly; (4) fixing type of purebred Southdown, Shropshire, and Hampshire sheep by means of selective breeding. The breeding flock at Beltsville at the close of the fiscal year consisted of 256 sheep of the Southdown, Shropshire, Hampshire, and Corriedale breeds.

At the United States Morgan Horse Farm, Middlebury, Vt., the breeding flock of sheep consisted of 251 animals, western ewes and Shropshire and Southdown rams and their progeny. Here the experimental work included (1) effect of "flushing" upon lamb yields; (2) early versus late lambing for market lamb production; (3) studies in growth; (4) a practical system of building up farm flocks of sheep for lamb and wool production by mating western ewes of the Lincoln-Rambouillet type with purebred Southdown and Shropshire rams and further top crossing with purebred rams of the respective breeds. In the comparison of early and late lambs there proved to be $3.47 a head more profit in the production of late lambs.

In the experiments in fixing type at both Middlebury and Beltsville the score system of mating is used, and improvement from the use of superior sires is already becoming evident. The records of weekly body weights and yearly fleece weights and measurements as kept at these farms are supplying data of genetic value.

### RANGE SHEEP INVESTIGATIONS.

The equipment of the United States Sheep Experiment Station at Dubois, Idaho, has been materially improved. Buildings now on hand make it possible to conduct such important phases of range sheep investigations as scoring, weighing sheep and wool, and selection of fleece samples with more dispatch and accuracy than has been possible in former years. The lambing sheds and paddocks now provide facilities for lambing a band of 1,500 ewes at a time in early spring. At the close of the fiscal year the flocks numbered 3,478 sheep of the Rambouillet, Corriedale, and Columbia breeds and crosses.

The principal lines of investigation are (1) a study of the effects of various methods of range management on the growth of wool and lambs; (2) developing and improving types of sheep adapted to the range; (3) methods of supplying sheep with water on dry grazing lands; (4) methods of wintering range sheep, including the production of winter feed on high arid lands; (5) range improvement through grazing studies.

The system of records, weighing, and scoring in use provides facilities for analyzing any question relative to these lines of investigation that is likely to arise. The data are completely tabulated and analyzed each year.

The breeding investigations are resulting in the development of a heavy shearing type of Rambouillet sheep with desirable mutton form. Sires of outstanding excellence are used, and the system of mating on the basis of the offspring scores is employed intensively. Improvement and type fixing of Corriedales and Columbias and the development of a type especially excellent in both fleece and form by the interbreeding of Corriedale-Columbia crosses are features of crossbreeding work at the station. These crossbred types appear to be well adapted to range territory where feed is sufficiently abundant to produce lambs for slaughter at approximately 4 months of age. During the past year the Columbia lambs averaged 72 pounds at between 3½ and 4 months of age. At the same age Corriedales weighed 60 pounds, while the offspring resulting from the interbreeding of Corriedale and Columbia crosses averaged 65 pounds.

### WOOL STUDIES.

The fleeces produced by the experimental sheep used for the farm and range projects are scored for fineness of fiber, length of staple, character, density, and distribution of the fleece over the back. All fleeces are weighed when shorn, and a sample weighing approximately 1 pound is taken from the side of the fleece produced by each sheep of the breed improvement series. These fleece samples are used in the wool laboratory to determine the percentages of grease, dirt, and clean wool. Results of examinations of 89 representative whole fleeces during the past two years show consistently that samples taken from the sides of the fleeces are distinctly more representative of the entire fleece than any other parts as an indication of the content of grease, dirt, and clean wool in the entire fleeces. Department Bulletin 1100, A Method of Determining Grease and Dirt in Wool, is in press.

### MILK-GOAT INVESTIGATIONS.

Marked improvement of the bureau's herd of milk goats at the Beltsville farm has resulted from the continued use of purebred Toggenburg and Saanen sires of outstanding merit in breeding and individuality. Goats having five consecutive top crosses of purebred sires have been produced. The herd numbers 39 animals. Complete records are kept of breeding, feeding, and milk production, and these records are used in the study of factors affecting the production of goats' milk. Milk has been supplied to families about Washington for the use of infants and invalids. This milk has been used according to the directions of attending physicians, and useful reports based on carefully kept records have been obtained.

## HORSE AND MULE INVESTIGATIONS.

### BREEDING AMERICAN UTILITY HORSES.

In the work for the development of a breed of mature utility horses for general farm and ranch work, conducted in cooperation with the State of Wyoming at Buffalo, Wyo., there were in the stud at the close of the fiscal year 12 mature stallions, 1 three-year-old stallion, 4 two-year-old stallions, 21 mature mares, 2 three-year-old mares, 2 two-year-old mares, 4 yearling mares, and 4 foals, a total of 50 animals.

The stallion Carmon 32917, which had been at the head of this stud since the work was begun, died during the year. The stallion Harvest Aid 63908, which has been used extensively during the past two years, has proved to be a prepotent sire and has been placed at the head of the stud. There is marked improvement in the standard of the stud since this stallion has been used in mating with mares of Carmon breeding. The remaining mature stallions were leased for public service in 1921 and practically all of them have been placed for the 1922 season.

### BREEDING MORGAN HORSES.

At the close of the fiscal year there were in the stud at the Morgan Horse Farm, Middlebury, Vt., 2 mature stallions, 1 four-year-old stallion, 1 three-year-old stallion, 1 two-year-old stallion, 1 yearling stallion, 15 mature mares, 3 four-year-old mares, 2 three-year-old mares, 8 two-year-old mares, 6 yearling mares, and 16 foals, a total of 56 animals.

The stallions Oakwood and Orient were transferred to the Remount Service of the War Department for use in breeding work for the Army. The stallion Scotland 6000 was sold to that department for the same purpose. Seven Morgan stallions bred in this project, including those named, are now standing for public service under the supervision of the War Department. The stallion Navarre 7238 and the mare Nadri 04056 were sold to the University of Porto Rico.

The stallion Troubadour 6459 has proved to be a very satisfactory sire, and since being used as the premier sire in this stud has sired colts of uniform size and quality. The average size and weight consistent with desirable Morgan type is being gradually increased. The stallion Bennington 5693 is being used rather extensively. There has been pronounced improvement in the stud at the Morgan Horse Farm during the past few years. The gradual development of the breeding operations at this farm is now becoming apparent and is reflected in the great demand for breeding stock bred by the department.

An interesting discovery has been made in the exhumation of a number of Morgan horses and finding that a majority had only 23 vertebræ instead of the customary 24 usually found in other breeds of horses except the Arab. This helps to substantiate the theory of the Arabian ancestry of the Morgan.

### FARM POWER STUDIES.

The bureau has cooperated with the Bureau of Public Roads and the Bureau of Markets and Crop Estimates in continuing the economic studies of the cost and utilization of power on farms in certain areas and the effect of the introduction of the tractor on farm-power requirements. The first study was made in the Corn Belt in a survey of 286 farms. During the last year the study was made in the Wheat Belt and consisted of a survey of 354 farms in that section. The results of these surveys, embodied in department publications, have brought out some interesting data concerning farm-power requirements. Studies relating to the efficiency of horses are being conducted at the experiment farm at Beltsville, Md., in cooperation with the Bureau of Public Roads.

### CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING PURPOSES.

Under the provisions of paragraph 397 of the tariff act of October 3, 1913, the bureau issued certificates of pure breeding for 967 foxes, 848 cattle, 591 dogs, 151 horses, 62 sheep, and 20 cats.

### POULTRY INVESTIGATIONS.

#### POULTRY FEEDING.

Thirty pens of fowls were used in feeding experiments, nine of which were yearling hens and the remainder pullets. Some of these pullet pens are on tests similar to those previously conducted, and others are on new tests with varying amounts and kinds of animal and vegetable proteins.

The new mash for the general-purpose breeds, such as the Plymouth Rock and the Wyandotte, containing only about 15 per cent of meat scrap and 33 per cent of ground oats and bran, continues to give good results in the second year in the two pens in which it is being used. The more stimulating, concentrated ration continues to give the best results with the Leghorns. A heavy ration of this latter kind is being used on a pen of Barred Plymouth Rock pullets in comparison with the new mash on another pen of the same breed. The results indicate the advisability of using less meat scrap and more bran and oats in rationing the general-purpose fowls.

Among the vegetable protiens, gluten meal seems to give the best results. The fish-meal tests seem to show results approximately equivalent to those obtained with meat scrap and high-grade tankage. The dried-milk products and semisolid buttermilk are giving excellent results, but these feeds are rather high in price.

## POULTRY BREEDING.

About 1,600 hens were trap nested, about 1,300 being pullets and the remainder older hens. The best individual production yet recorded in this work has been obtained this year. This will result in a larger number of high-record hens being available for use in breeding for increased egg production. In addition, the best previous egg record has been exceeded.

The general plan in the breeding work has been directed toward not only improvement in egg production but the maintenance of breed character and standard excellence and quality. As heretofore, the best success in this combination has been with the Single Comb White Leghorns and Rhode Island Reds. The remarkable improvement in egg production and general quality of the Barred Plymouth Rock during the past two years has been fully maintained, a further increase in the number of high-record hens in this breed being made. To the material progress in these three breeds the addition of another must be noted in the White Wyandotte. A pullet of this breed not only made the best record during the year but exceeded any made previously. The Silver Spangled Hamburgs, usually classed as an ornamental variety, also made good egg records, one pullet having laid 227 eggs.

Specimens of stock in these breeds were exhibited at the Madison Square Garden Poultry Show, in New York City, as has been customary for several years. The approximation to standard requirements of type, color, breed character, and excellent general quality, coupled with their high records of production, elicited favorable comment.

The breeding work with the new breed, the Lamona, is still being carried on. The red ear lobes, white plumage, yellow legs and skin, four toes, with good length and breast development of body, seem to be definitely fixed. The combination of red lobes and white eggs, however, has not been fully perfected. The percentage of increase in the number of hens showing correlation in these characters indicates progress. As the original intent was to produce a general-purpose breed laying a white egg, the distribution of stock will not be undertaken until this combination of red-lobe and white-egg character becomes more fully fixed.

Partial results from an experiment begun in the fall of 1920 to increase flock production by selective breeding without the use of the trap nest are now available. These indicate that selection of breeding stock founded on the external evidences of good production and principally lateness of molt is sound practice. The daughters of the late-molting hens matured early and during a period of seven months show considerable increase both in number of eggs and in value over the original flock. This work is being continued for verification of results.

### SOUTHWESTERN POULTRY INVESTIGATIONS.

Experimental breeding and feeding investigations with Single Comb White Leghorns and Single Comb Rhode Island Reds are being carried on at Glendale, Ariz. The stock was obtained from the Beltsville farm and the trap-nesting and pedigree work is being conducted along similar lines. Considerable information on the hatching, brooding, rearing, housing, and feeding of poultry under conditions in this Southwest section has already been obtained.

Bronze-turkey breeding stock has recently been purchased on the Pacific coast and is now at Glendale, to be used in feeding and breeding investigations. The natural conditions and environment seem favorable for turkey production.

### PIGEON AND SQUAB INVESTIGATIONS.

The loft of racing homing pigeons, having served its purpose, has been materially reduced, only a good breeding nucleus being maintained. The data on this work are available for publication.

The squab-breeding pigeons have increased in number and the younger stock in the Red and Yellow Carneaux will replace many of the older birds. A few pairs each of White Kings and White Runts have been purchased to obtain new blood. Data on feed cost of squab production, breed comparison in prolificacy, and rate of growth and weight are being accumulated.

## DAIRY DIVISION.

The work of the Dairy Division, under Dr. C. W. Larson, chief, progressed in line with the present policy of discontinuing extension work and devoting more time to research problems. In the course of this reorganization the dairy extension section and the dairy manufacturing section were merged to form the dairy introduction section January 1, 1922. Under this arrangement fewer men are needed to do the introduction work, and this has made it possible to enlarge the corps of scientific workers on research problems.

### DAIRY INTRODUCTION.

The principal work of the new dairy introduction section is to introduce, in cooperation with or through State extension forces, new or improved methods, practices, and ideas. Direct and substantial assistance is furnished until the projects are properly established, then the assistance is withdrawn and the work is left to the direction of State or other local agencies. Regular extension projects in both production and manufacturing are being discontinued. Much of the work formerly done by the Dairy Division has been continued by the States. The activities of the introduction specialists are centered principally about the following subjects: Cow-testing associations, bull associations, utilization of dairy products, Swiss cheese manufacture, American cheese manufacture, creamery operation, and butter making.

### COW-TESTING ASSOCIATIONS.

The study of cow-testing association records has been continued. Two department bulletins have been published—No. 1069, Relation of Production to Income from Dairy Cows, and No. 1071, Influence of Season of Freshening on Production and Income from Dairy Cows. From the lowest producing group of cows to the highest producing group a gain of 50 pounds in average yearly production of butterfat was always accompanied by an increase of about $16 in income over cost of feed.

The average production of the 21,234 cows whose 12-month records have been studied was 6,077 pounds of milk and 248 pounds of butterfat, or about 50 per cent above the average of all the dairy cows in this country. The records show that selection of animals and better methods of feeding raise average production rapidly during the first year or two that the cow-testing association is in operation, but the figures for subsequent years show small gains. This indicates that there is still much room for improvement in the breeding of cow-testing association cows.

On July 1, 1922, there were in operation 513 associations, including 12,458 herds and 215,321 cows, as compared with 452 associations a year previously. In the two States where this division cooperated actively in this work the number of associations increased to a marked extent. In Minnesota the increase was from 23 to 37 active associations and in Wisconsin from 103 to 127.

### COOPERATIVE BULL ASSOCIATIONS.

The number of bull associations increased from 158 to 190, owning 857 bulls. These associations are formed for the cooperative ownership and use of good purebred bulls for the purpose of improving the breeding of dairy cattle. Texas, Nebraska, and Ohio are new additions to the list of States where bull associations have been formed. Three men worked during the whole year in Minnesota, South Carolina, and Vermont, each concentrating his work in one State. Incidentally some work has been done in Illinois, Nebraska, North Carolina, and Ohio, with the result that the dairy extension specialist in Illinois has organized five new associations. In April one man was put on to do bull-association work in connection with the western office.

Some of the most interesting features revealed by the investigations concerning bull associations are that an association always provides, in place of the mixed lot of bulls of varied breeds and value, uniform bulls as good as or better than the best in the community before; that even the grade herds belonging to the members look like purebred herds after five or six years of bull-association operation; that when properly organized the associations continue in operation without much difficulty and the members become more enthusiastic over the organization as time goes on. The greatest problem at the present time, as in the past, is to speed up the formation of organizations. Disease control, as it applies to bull associations, has had special attention. With proper precautions there is apparently little danger from the use of the same bull in several herds.

### UTILIZATION OF DAIRY PRODUCTS.

The work in the interest of milk utilization has been for the most part a continuation of the educational "milk-for-health" campaigns. This work is done in cooperation with the extension services of the agricultural colleges, cooperating agencies including the State leaders, the dairy and food specialists, college publicity departments, the county agents, and the home demonstration agents. The campaigns are, when possible, made on the basis of covering a city, a township, a county, or even a whole State. The part taken by the Dairy Division is in the nature of a demonstration with a view to introducing methods and subject matter. The State agricultural college furnishes extension workers, both county and State, and thus a campaign may be quickly extended over a State. The Dairy Division cooperated definitely with nine States, five counties, and nine cities. The results of all these campaigns show an increased use of milk in both cities and rural communities, the reported increases ranging from 5½ to 20 per cent. Reports from schools show a reduction in malnutrition and an improvement in health, conduct, and scholarship.

### AMERICAN CHEESE INTRODUCTION.

The manufacture of American cheese in the southern mountains, which began with the organization of a cheese factory in Watauga County, N. C., in 1914, has grown gradually and spread to the neighboring States. During the last year more than 40 factories were in operation in North Carolina, Tennessee, and Georgia. Cheese specialists have been employed in cooperation with the extension departments of these States, and an industry of considerable importance is being established. The work of the specialist is primarily instituting new factories, supervising the installation of equipment, instructing cheese makers in manufacturing methods, and educating farmers in the production and care of milk. The quality of cheese made is good, and the product is sold almost exclusively in the South on the basis of northern market quotations. The output of the factories this season shows some increase over last and new factories have been started.

### SWISS CHEESE INTRODUCTION.

By the proper use of certain cultures developed in the Dairy Division and by following up-to-date manufacturing methods, the quality of domestic Swiss cheese can be greatly improved. That the results of the division's investigations might become available to manufacturers, introduction demonstrations in the cultural methods of making Swiss cheese have been carried on in cooperation with the extension departments of Wisconsin, Ohio, Michigan, and North Carolina. In general the plan followed has been to select a limited number of properly equipped factories where the operators agree to follow instructions. All details of manufacture, including the proper use of cultures, are then supervised by a trained Swiss-cheese specialist. The results have been highly satisfactory. In one State the quality of cheese made in the demonstration factories graded over 85 per cent fancy and No. 1 for the season, while the same factories before using cultures produced less than 30 per cent fancy and No. 1 cheese. In another State the output of demonstration factories was sold at a price 30 per cent higher than that obtained by neighboring factories not using cultures.

### CREAMERY OPERATION.

Creamery introduction work has been carried on in Tennessee, Mississippi, Louisiana, and North Carolina. Efforts have been directed toward improving the quality of milk and cream delivered to creameries, the quality of the product manufactured, and the general efficiency of operation. Special attention has been given to creamery records and cream grading. Assistance has been given new creameries in planning and installing the equipment. The sale of dairy products through creameries in the States named is proving very satisfactory to the farmers. The output of the creameries is on the increase.

### THE GROVE CITY CREAMERY.

The Grove City Creamery, Grove City, Pa., on April 30 completed its seventh year of operation under the supervision of the Dairy Division. Butter continues to be the principal product, but condensed skim milk, plain and sweetened, and Swiss, Roquefort, Camembert, Cheddar, cottage, and club cheeses have also been made in relatively large quantities. Milk and cream for household use have been pasteurized and prepared for local retail sale as in former years. Prior to April 1 these products were sold only at the creamery, but on that date delivery by wagon was begun, and as a result sales have materially increased. The preparation of ice-cream mixes for use by ice-cream manufacturers was begun during the year and is proving very popular. The mix is ready for freezing when shipped from the creamery. The quality of the products made has been kept at the same high standard as in previous years, and in the case of Swiss and Roquefort cheese some improvement has been made. An addition to the creamery building has been made recently to provide space for the manufacture and canning of evaporated milk.

Since efficiency of operation is measured largely by the cost of production, this subject has received consideration through a study of the unit cost of manufacturing creamery products at the Grove City Creamery. This study included 11 different products, the total cost of each being divided into numerous items on which separate figures are desired for making a detailed analysis.

### SUPERVISION OF BUTTER FOR THE NAVY.

Cooperation with the Navy Department in obtaining for the Navy butter made from sweet cream under definite manufacturing standards has been continued. Seven creameries having contracts for Navy butter produced 800,168 pounds under the supervision of the

Dairy Division. Samples to the number of 131 were taken at the contract creameries at regular intervals and were scored after being in storage from 10 to 12 months. The average score was 92.93, which was only 2.07 points less than at time of manufacture. This butter is noted for its fine flavor and excellent keeping qualities.

### RENOVATED-BUTTER INSPECTION.

The inspection of renovated-butter factories was conducted at 8 plants, whose output was 5,355,863 pounds, a decline of 778,171 pounds from the preceding fiscal year. Particular attention is paid to the sanitary condition of the factory, quality of packing stock used, and manufacturing processes employed.

### WESTERN DAIRY INTRODUCTION.

The dairy industry in the Western States has been furthered in several ways. The appointment of a bull-association specialist and a cow-testing association specialist resulted in marked activities in these lines. Six new bull associations with 20 bulls, providing for the breeding of about 827 cows, were organized, and foundation work was done on 8 other associations. There are now 19 bull associations in the western territory. The cow-testing association leader conferred with the extension directors in 6 States, visited 23 associations, and assisted in reorganizing 4 associations. Twenty associations reporting to the western office are free from scrub bulls. Approximately 150 scrub and grade bulls have been replaced by purebreds as a result of an active campaign for this purpose. There are 51 cow-testing associations in this territory.

Cream grading, by which cream is paid for on a quality basis, was introduced in 11 creameries. The creamery field man visited 71 creameries in 9 States, assisted 2 agricultural colleges in short courses, and scored 712 samples of butter and cheese in contest work. In market-milk work 31 surprise contests were held, in which the milk supplies of 48 cities were represented. There were scored 1,543 samples of milk and 50 samples of cream. Thirty-seven dairies and 42 milk plants were visited, and the project leader superintended two students' judging contests. In the work relating to Cheddar cheese surprise judging contests were held and 157 samples scored. Cheese was made for demonstration in 19 factories.

The Dairy Division is cooperating with the extension department of the University of California in a dairy development project at Delhi, Calif., in which considerable progress has been made.

Members of the western office had charge of the educational booths at the Pacific International Live Stock Exposition and assisted in judging dairy products at the Stockton (Calif.) dairy show.

### SUPERVISION OF JUDGING CONTESTS.

The Dairy Division supervised three students' judging contests at the National Dairy Show at the Minnesota fair grounds in October, 1921. These contests are very helpful in unifying the instruction in judging dairy cattle and dairy products in agricultural colleges and high schools.

## MARKET MILK INVESTIGATIONS.

The work of the market milk section has undergone a considerable change. Much less inspection work has been done in cooperation with cities and more investigational work has been accomplished. The cities are now better equipped to handle inspection for themselves, and much of the standardization work can be carried on by correspondence.

### DAIRY SANITATION.

At Hyattsville, Md., a survey was made of the milk supply in which 8 dairies were inspected and 45 samples of milk taken for analysis. A report was made to the health officer with recommendations for a new ordinance and its proper enforcement. At Baltimore, Md., instruction was given local inspectors in the bacteriological examination of empty milk cans.

At Grove City, Pa., an effort was made to obtain a better quality of milk supply for use in making Swiss cheese. The milk from 11 farms producing high-grade milk was selected for making experimental cheese, and all cheese made was satisfactory. Later it was decided to make cheese from milk of all producers desiring to try for the bonus for high-quality milk. During a period of 13 days, when 33 cheeses were made, 26 were of good quality. The improvement in quality of milk obtained led to further work along this line. A survey of the farms made at that time provides a permanent record of conditions, facilities, and resources available.

### MILK-PLANT MANAGEMENT.

A milk-plant specialist visited Dubois, Pa., Norfolk, Va., Williamsport, Pa., Strasburg, Va., and Grove City, Pa., where assistance was given in plant operation and in the selection of suitable sites and equipment for new plants. Assistance was also given by correspondence with regard to the construction, management, and equipment of 37 milk plants. Plans for milk plants were sent to 20 addresses, and information on cooperative milk plants was furnished in response to five inquiries. Arrangements were made to obtain the cooperation of milk plants in five cities for study of labor requirements.

### REQUIREMENTS FOR MILK PRODUCTION.

Field work in Delaware on the requirements for producing milk was completed and the data were tabulated and prepared for publication. With the investigations in seven States now completed, studies will be made of all the data collected. The studies have shown a definite relation between feed cost of a dollar's worth of milk and profit. Those dairymen whose feed costs were below 50 cents for each dollar's worth of milk produced generally made a profit; those with feed costs between 50 and 65 cents were in the danger zone, and those above 65 cents were generally operating at a loss. A summary of the herd records from seven States shows that the greatest yearly net profit of any dairyman was $5,513.45. Twenty per cent of the dairymen sustained losses ranging from $113.55 to $1,988.84 a year.

### CLEANING MILKING MACHINES.

During investigations relative to the cleaning and sterilizing of milking machines 291 samples of machine-drawn milk were taken for bacterial counts. The results show that the heat method of sterilization is so far the most efficient and practicable. Of all samples taken from machines properly sterilized by the heat method, the average bacterial count was 11,200. The use of this method caused great reductions in the bacterial content of milk produced on a number of farms where tests were made. Experiments with the salt-and-chlorin solution indicated that for cleaning milking machines this solution was no more effective than the plain chlorin solution. A set of simple instructions in the use of the heat method was sent out in circular letters to health officers and through the press.

### OTHER ACTIVITIES.

Field observations on the use of metal tanks for transporting milk on railroads and motor trucks have led to the following conclusions: Metal tanks on railway flat cars can be used successfully in transporting milk and partially condensed milk, especially when full-tank shipments are made. Pick-up shipments of milk have not proved desirable so far. Metal tanks mounted on motor trucks or horse-drawn vehicles are in successful use. More thorough methods of cleaning tanks and greater care in selecting sizes and types to fit the work to be done are recommended.

A study of the bacterial counts in cream and skim milk after separating centrifugally indicated that these counts approximated closely the original count of the whole milk.

A tabulation of data from 180 tests showed that there were 338 per cent more bacteria in fresh milk produced with unsterile utensils than in milk produced in sterilized utensils. After standing for 24 hours at 60° F. the count was 630 per cent greater for milk in unsterile utensils. Other tests showed that where steam was not available thorough washing caused a marked reduction in bacterial counts.

The experiments in connection with the effect of silages on the flavor and odor of milk were completed and a manuscript on this subject was prepared for publication. It was found that relatively heavy feedings of silage could be fed to cows one hour after milking without affecting the milk. Silage odors and flavors were absorbed largely through the body of the cow rather than from the air. Aeration of the milk while still warm reduced or eliminated silage flavors and odors. Green alfalfa fed in relatively large quantities one hour before milking gave marked odors and flavors to milk, but when as much as 30 pounds was fed after milking there was practically no effect on the milk from the next milking.

Experiments on the whipping quality of cream were concluded and a manuscript reporting the work was prepared for publication. Age, richness, and low temperature at time of whipping were found to be essential to good whipping quality.

The results of experiments on the feathering of cream in coffee, completed last year, were tabulated, and a manuscript has been prepared for publication.

## DAIRY RESEARCH LABORATORIES.

### NUTRITION OF DAIRY COWS.

The feeding experiments on the effect of rations low in calcium and phosphorus are still under way and are giving positive results. The cows on a low-phosphorus ration did not eat enough to supply total nutrients required, and a phosphorus supplement had little or no effect on the milk yield. The cows on a low-calcium ration ate more than enough to supply their requirements for both protein and total nutrients, but the milk yield of those giving more than 25 pounds of milk a day fell off rapidly. Cows on the same ration supplemented with half a pound of ground limestone daily showed a much less rapid drop in milk yield.

Cows on a ration of grain, alfalfa hay, and corn silage, which contained about the same quantities of protein and total nutrients as a timothy-hay ration, maintained their milk yield somewhat better than those which had the timothy-hay ration with the limestone supplement. There is some indication that the calcium deficiency has some effect on the reproductive function, and the evidence on this point is being carefully followed.

### BACTERIOLOGY AND CHEMISTRY OF MILK.

The characteristics of several species of the streptococci which may occur in milk have been determined with considerable accuracy by the study of a large number of cultures from definite sources. This and some other research work is too technical for detailed description in this report.

It has been definitely established that the accessory substances which promote the growth of bacteria are not identical with vitamins, at least in the ordinary acceptance of the term. Methods which remove the water-soluble vitamin from yeast extract do not affect its ability to promote the growth of bacteria.

The stimulating effect of fats and oils is not confined to those of vegetable or animal sources but is true also of mineral oils even when present in extremely small traces.

On account of a proposal to ship milk at high temperatures an investigation has been begun on the nature of the bacteria which grow at temperatures between 40° and 70° C. In 6 hours at 60° C. there is a slight increase in bacteria, but in 24 hours the number reaches millions.

The very general use of chlorin compounds to sterilize dairy utensils has suggested that these may be used as a preservative for milk. A test has been devised by which it is possible to detect 1 part of chlorin in 50,000 parts of milk.

The value of the alcohol test in detecting abnormal milk has been demonstrated. Milk which reacted to the alcohol test and which had an abnormally low coagulating temperature when evaporated was traced to cows which had been fed moldy or decayed silage.

### MANUFACTURE OF WHOLE MILK AND CREAM PRODUCTS.

Ice cream.—The influence of the composition of the mix on palatability of ice cream has been studied by selling ice cream to a considerable number of persons and allowing them a choice of three concentrations of varying ingredients. The results showed that a large majority preferred an ice cream with high fat content and that the choice was also usually in favor of the higher concentration of milk solids not fat and sugar and gelatin.

Studies of the influence of different ingredients on the yield show that increases in the percentages of gelatin, milk solids not fat, and sugar tend to lower the yield. Fat increases the yield in homogenized mixes, and homogenizing produces a higher final yield in mixes low in fat and in solids not fat, but under other conditions the effect is not pronounced. Low brine temperatures tend to lower the yield.

Investigations indicate that ice cream has no freezing point in the usual sense. The freezing is rather the continuous precipitation of solids from saturated solution with the lowering of the temperature. This work has developed a method for measuring the "sandiness" of ice cream.

Condensed milk.—Studies on the physical chemistry of milk are giving information of value in explaining and correcting difficulties which occur both in sweetened and evaporated milk. It has previously been observed that forewarming to the usual temperatures greatly increases the tendency to thicken on standing. More recent studies indicate that by increasing the forewarming temperature two or three degrees the tendency of the milk to thicken may be obviated. The effect of the concentration of milk solids not fat on the temperature of coagulation has been determined. The change in the coagulation temperature per 1 per cent variation in solids not fat between 16 and 36 per cent is about 1.5° C. Homogenization of milk of low concentration lowers the coagulation temperature, but homogenization at pressures below 4,000 pounds has no effect on the coagulation of milk of normal composition.

Swiss cheese.—Studies have been made of the effect of certain variations of the manufacturing process on the texture of Swiss cheese. The time of holding in the kettle seems to have little influence on the quality of the cheese, but small differences in the cooking temperatures appeared to have a decided effect in suppressing abnormal gas formation. Cheese made from milk passed through a separator had fewer eyes of a much larger size than those in the check cheeses. Very definite relations have been established between the composition of the milk and what is known as glass cheese. A method of determining casein has been adapted to factory conditions so that it is possible to control this factor. The use of cultures has been put on an introduction basis and very satisfactory results were obtained with factories in Ohio and Wisconsin.

Some attention has been given to the problem of disposing of second-grade Swiss cheese. This is now done commercially by heating the cheese with the addition of some neutralizing agent and running it into molds. This process is covered by patents and its use is necessarily limited. A molded cheese of satisfactory flavor may be made by heating carefully without neutralizing, but the texture is objectionable.

No special investigations have been made on Camembert or Roquefort cheese, but considerable experience has been gained from their manufacture on a commercial scale at Grove City, Pa. A method of handling the curd for Camembert which reduces the labor appreciably has given a satisfactory product. The brown discoloration of Roquefort, which has given trouble in the past, has been found to be due to delay in wrapping in tin foil.

On the basis of the results obtained with Pecorino cheese made at Grove City, another series has been started with the object of reducing the dryness and hardness. Additional curing-room space has been provided at Washington, and a considerable quantity of cheese of the Parmesan and Romanello type is being made for long storage.

### UTILIZATION OF SKIM MILK, BUTTERMILK, AND WHEY.

Studies have been made on the vapor pressures of skim-milk powder in relation to its aging and solubility. As a powder ages, there is a measurable variation in the amount of water it will absorb.

It has been found practicable to produce by 14 days' fermentation from 5 pounds of lactose a mixture of 1 pound of acetic and 2.35 pounds of propionic acid. This is about 90 per cent of the theoretical yield. Attention is now being given to products obtained by the direct oxidation of lactose.

Dried whey and dried buttermilk have been furnished to the Animal Husbandry Division for feeding experiments with chickens. In the first half of the 12-month experiment the pen receiving dried whey produced more eggs than any other pen.

Considerable quantities of dried whey have been made on a small commercial scale at Grove City. About 4 pounds of crude sugar and 1½ pounds of dried whey containing about 30 per cent of albumin were obtained from each 100 pounds of whey. The dry whey has been sold at 25 cents a pound to a laboratory making an infant food. This has given a profit over the cost of manufacture.

### DAIRY EXPERIMENT FARM.

The work at the dairy experiment farm, Beltsville, Md., has steadily increased. An adjoining farm of 129 acres has been leased and is being cleared. This additional land will permit of a more extensive use of pasture and will provide for the natural increase of the dairy herd for several years. Because of the presence of abortion and other genital diseases the health of the herd was not satisfactory. An average of 27 cows and 12 calves have been on experiments of various kinds at all times during the past year, and in addition the cows on official test have provided much valuable data.

### DAIRY CATTLE MANAGEMENT STUDIES.

Cows kept under test conditions were found to produce, on the average, about 60 per cent more milk and butterfat than those kept under ordinary herd conditions. Most of the work at present is in determining the effect of each one of the factors responsible for the higher production. So far only 20 per cent of the increase has been satisfactorily accounted for. Five per cent was due to keeping cows in box stalls as compared with stanchions.

One of the commonly accepted rules of dairying is that cows should be milked at regular intervals. To test this, cows were milked at the same hour each day as compared with milking at random. It was found with cows of average production that irregular milking was not detrimental to milk and butterfat production.

An experiment conducted during the winter shows that cows of average production and under weather conditions prevailing on the farm at Beltsville, Md., gave practically the same milk yield when the drinking water was cold as when warmed. The experiment will be continued on a farm in a colder climate.

In an experiment to determine the effect of exercise on production it was found that while the production was about the same whether the cows were exercised or kept in the barn, the cost of production was considerably higher with the cows which were exercised to the extent of being driven 3 miles a day. It was found, too, that exercise increased slightly the fat content.

### FEEDING INVESTIGATIONS.

The feeding of cactus to dairy cows causes a decrease in the butterfat percentage in the milk. Experiments so far made show that neither the water nor the calcium in the cactus is the cause of the decrease. The next step will be to find out the effect of magnesium. Other feeds which were found to influence the per cent of fat in milk are linseed-oil meal and cottonseed meal. Linseed oil increased the test the same as the linseed-oil meal, which indicates that it is the oil rather than the protein which affects the test. Work is still being done to determine whether the results observed are permanent or only temporary; also to find out whether high-protein feeds which are not rich in oil will have an effect similar to the linseed and cottonseed meals.

The work with milk gruels and special feed mixtures for calf feeding has been mainly along the line of reducing the cost of the mixtures prepared at this station.

A considerable number of calves have been fed with a nipple as compared with drinking from a pail. The results show no advantage in feeding with a nipple.

Pectin pulp, a by-product in the manufacture of pectin from apple pomace, was found to be less palatable and less valuable as a dairy feed than beet pulp.

Results of feeding experiments in which cows were fed according to ordinary feeding standards for production in comparison with certain amounts above those standards indicate that feeding at standard holds the cows at approximately stable body weight and probably produces milk at lowest cost of production per milk unit, but that under certain conditions higher feeding might be more profitable.

An experiment was conducted with a view to finding out whether there was any advantage in the use of molasses in the dairy ration. In one experiment molasses was fed to test cows in comparison with hominy feed, with the result that cows fed hominy produced 3 per cent more milk. In another experiment a group of cows that were given molasses in addition to the regular ration produced slightly less than the group that received the regular ration only.

### DAIRY STATISTICS.

The trend of dairying has been followed through a study of foreign and domestic statistics from all sources. The information obtained was compiled and indexed for convenient reference as an aid in keeping the division in close touch with general developments in the dairy industry. Some original material on the consumption of milk and cream in the United States and on similar subjects was gathered in cooperation with other bureaus when this information was not otherwise available.

The chart on the balance of trade in dairy products was again prepared this year and sent out to the dairy industry. A report on the production and uses of milk for publication in the Yearbook was prepared in cooperation with the Bureau of Markets and Crop Estimates. A set of charts was prepared for the use of the Dairy Division in exhibit work, and a Handbook of Dairy Statistics was completed for publication.

### DAIRY CONSTRUCTION AND EQUIPMENT.

The technical staff prepared plans and specifications for construction work and equipment required by the division and performed the necessary surveys, inspection of materials, and superintendence of construction of new buildings at the Beltsville dairy farm, the Grove City Creamery, and the field station at Woodward, Okla. Three new laboratories were planned and constructed in the Dairy Division.

Information on building and equipment was furnished to dairymen and others by correspondence, and 586 blue-print plans were sent out.

Assistance has been given to various divisions of the bureau in making plans, calculations, and specifications for the installation or enlargement of refrigerating plants, temperature control, electrification, and pumping plants at Washington and at field stations for both research and practical purposes. Assistance was also rendered to the Bureau of Chemistry, the Bureau of Plant Industry, and the University of California in electrical equipment, temperature control, and humidity control in the prosecution of various practical investigations.

### DAIRY-CATTLE BREEDING.

Dairy-cattle breeding projects are being carried on in five herds owned by the bureau, comprising 374 registered purebreds and 65 grades, a total of 439 animals. In addition, cooperative breeding experiments are being carried out with seven agricultural colleges. At the close of the fiscal year 46 bulls lent from bureau herds to farmers and institutions in the vicinity of these herds were in service among more than 500 cows for the purpose of testing the ability of the bulls to transmit milk and butterfat production.

In West Virginia a breeding experiment has been begun in cooperation with the State experiment station and P. O. Reymann, president of the Ayrshire Breeders' Association, in which the registered Ayrshires in two herds, totaling some 300 head, will be used in a project in which related and unrelated proved sires will be used for a number of generations.

As a part of the routine of the breeding project, 32 official records have been completed by cows in the bureau-owned herds, the average record being 10,910.7 pounds of milk and 461.36 pounds of butterfat. Only 8 of the records were made by mature cows, and 14 of them were made by cows under 3 years of age. Records of feed consumption of the tested cows were also kept. A comparison of records of cows made on rations in which a grain mixture is received one year in addition to roughage, and is followed by a lactation in which roughage only is received, is in progress at the field station at Huntley, Mont. Four of the records mentioned above were made on roughage alone.

A study of the effect of age and development on the production of Jersey and Guernsey cows has been completed, also a genealogical study of Holstein-Friesian sires and a study of the transmitting ability of 23 Holstein-Friesian sires. A tabulation that will show the transmitting ability of Guernsey Advanced-Register sires is in progress.

## MEAT INSPECTION DIVISION.

The Federal meat inspection, conducted by the Meat Inspection Division, under Dr. R. P. Steddom, chief, shows an increase over the preceding year in the total number of animals slaughtered, in the quantity of meats processed, and in the quantity of meat and products certified for export.

### INSPECTION OF DOMESTIC MEATS.

Inspection was conducted at 899 establishments in 263 cities and towns, as compared with 892 establishments in 265 cities and towns during the fiscal year 1921. Inspection was begun at 68 establishments and withdrawn from 46, as compared with 62 and 61, respectively, during the preceding year. Inspection was withdrawn from 45 establishments on account of discontinuance of interstate business and from 1 on account of violation of the meat-inspection regulations.

### ANTE-MORTEM AND POST-MORTEM INSPECTIONS.

The ante-mortem and post-mortem inspections are given in the following tables:

*Ante-mortem inspection of animals.*

| Class of animals. | Passed. | Suspected.[1] | Condemned.[2] | Total inspected. |
|---|---|---|---|---|
| Cattle | 7,751,584 | 121,179 | 18 | 7,872,781 |
| Calves | 3,910,261 | 3,613 | 1 | 3,913,875 |
| Sheep | 11,965,998 | 1,861 | 11 | 11,967,870 |
| Goats | 13,754 | 5 | ............ | 13,759 |
| Swine | 39,359,611 | 86,636 | 2,793 | 39,449,040 |
| Horses | 1,897 | 1 | 4 | 1,902 |
| Total | 63,003,105 | 213,295 | 2,827 | 63,219,227 |

[1] This term is used to designate animals found or suspected of being unfit for food on ante-mortem inspection, most of which are afterwards slaughtered under special supervision, the final disposal being determined on post-mortem examination.

[2] For additional condemnations see succeeding tables.

*Post-mortem inspection of animals.*

| Class of animals. | Passed. | Condemned. | Total inspected. |
|---|---|---|---|
| Cattle | 7,816,287 | 55,170 | 7,871,457 |
| Calves | 3,912,847 | 11,408 | 3,924,255 |
| Sheep | 11,957,958 | 10,476 | 11,968,434 |
| Goats | 13,728 | 30 | 13,758 |
| Swine | 39,256,306 | 160,133 | 39,416,439 |
| Horses | 1,872 | 26 | 1,898 |
| Total | 62,958,998 | 237,243 | 63,196,241 |

The next two tables show the diseases and conditions for which condemnations were made.

*Diseases and conditions for which condemnations were made on ante-mortem inspection.*

| Cause of condemnation. | Cattle. | Calves. | Sheep. | Goats. | Swine. | Horses. |
|---|---|---|---|---|---|---|
| Abscess | | | | | 62 | |
| Arthritis | | | | | 4 | |
| Chronic elephantiasis | | | | | | 1 |
| Emaciation | 1 | 1 | | | 28 | |
| Hog cholera | | | | | 1,569 | |
| Injuries | | | 1 | | 12 | |
| Lymphangitis | | | | | | 1 |
| Metritis | | | | | 2 | |
| Moribund | 3 | | 2 | | 23 | |
| Pneumonia | | | 1 | | 281 | |
| Pyemia | | | | | 2 | |
| Pyrexia | 11 | | 7 | | 793 | |
| Septicemia | 2 | | | | 5 | |
| Swine plague | | | | | 11 | |
| Tetanus | | | | | 1 | 2 |
| Tuberculosis | 1 | | | | | |
| Total | 18 | 1 | 11 | | 2,793 | 4 |

*Diseases and conditions for which condemnations were made on post-mortem inspection.*

| Cause of condemnation. | Cattle. | | Calves. | | Sheep. | | Goats. | | Swine. | | Horse carcasses. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | |
| Actinomycosis | 786 | 99,571 | 27 | 1,537 | | 4 | | | | 8 | |
| Arsenic poisoning | 9 | | | | | | | | | | |
| Asphyxia | 3 | | 6 | | 45 | | | | 1,653 | | |
| Blackleg | 2 | | 8 | | | | | | | | |
| Bone diseases | 45 | 5 | 55 | 3 | 107 | 48 | | | 2,928 | 31 | |
| Caseous lymphadenitis | | | | | 710 | 19 | 6 | 21 | | | |
| Cellulitis | | | | | | | | | 39 | 923 | |
| Congestion | 7 | | 12 | | 9 | 2 | | | 30 | 2 | |
| Contamination | 1 | 2,618 | 1 | | | 2 | | | 338 | 370 | |
| Cysticercus | 130 | 1,226 | 20 | | 202 | 13 | 1 | | 217 | 3 | |
| Dropsical diseases | 18 | 1 | 6 | | 8 | | | | 95 | | |
| Emaciation | 2,767 | | 2,009 | | 2,195 | | 15 | | 756 | | 3 |
| Excessive scalding | | | | | | | | | 3 | | |
| Frozen | | | 3 | | | | | | 3 | | |
| Gangrene | 52 | | 17 | | 11 | | | | 33 | | |
| Hog cholera | | | | | | | | | 32,562 | | |
| Hydronephrosis | | | | | 1 | | | | 5 | | |
| Icterus | 84 | | 130 | | 1,247 | | | | 4,619 | | |
| Immaturity | | | 5,087 | | | | | | | | |
| Injuries, bruises, etc. | 1,756 | 382 | 405 | 67 | 734 | 113 | | | 1,461 | 10,630 | |

*Diseases and conditions for which condemnations were made on post-mortem inspection*—Continued.

| Cause of condemnation. | Cattle. | | Calves. | | Sheep. | | Goats. | | Swine. | | Horse carcasses. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | Carcasses. | Parts. | |
| Leukemia | 317 | | 17 | | 9 | | | | 198 | | |
| Melanosis | 42 | 11 | 60 | 12 | 21 | | | | 156 | | 2 |
| Moribund | 10 | | 10 | | 70 | | 1 | | 294 | | |
| Necrobacillosis | 3 | | | 2 | | 244 | | | 2 | | |
| Necrosis | 6 | 759 | | | | | | | 3 | 2 | |
| Parasitic diseases | 6 | 15 | | | 39 | | | | 151 | 4 | |
| Phlebitis | | | 468 | | 2 | | | | 3 | 1 | |
| Pneumonia, peritonitis, enteritis, metritis, pleurisy, etc | 5,952 | | 1,574 | | 3,984 | | 2 | | 23,852 | | 13 |
| Pregnancy and recent parturition | 127 | | | | 66 | | | | 10 | | |
| Septicemia, pyemia, uremia, etc | 2,582 | | 553 | | 766 | | 2 | | 15,405 | | 7 |
| Sexual odor | | | | | 4 | | | | 2,774 | | |
| Skin diseases | | | 1 | | 11 | | | | 42 | 16 | |
| Texas fever | 65 | | 176 | | | | | | | | |
| Tuberculosis | 39,434 | 60,441 | 659 | 466 | 3 | | 2 | | 70,304 | 666,787 | 1 |
| Tumors and abscesses | 966 | 1,906 | 104 | 289 | 202 | 51 | 1 | | 2,197 | 18,616 | |
| Total | 55,170 | 166,935 | 11,408 | 2,376 | 10,476 | 496 | 30 | 21 | 160,133 | 697,393 | 26 |

The following table shows the total condemnations on ante-mortem and post-mortem inspections combined:

*Summary of condemnations.*

| Class of animals. | Animals or carcasses. | Parts. |
|---|---|---|
| Cattle | 55,188 | 166,935 |
| Calves | 11,409 | 2,376 |
| Sheep | 10,488 | 496 |
| Goats | 30 | 21 |
| Swine | 162,926 | 697,393 |
| Horses | 30 | |
| Total | 240,071 | 867,221 |

In addition to the foregoing, the carcasses of 88,844 animals found dead or in a dying condition were tanked, as follows: Cattle, 2,135; calves, 3,449; sheep, 8,210; goats, 36; swine, 75,010; horses, 4.

### INSPECTION OF MEAT AND PRODUCTS.

The inspection and supervision of meats and products prepared and processed are shown in the following table, which is a record only of inspection performed and not a statement of the aggregate quantity of products prepared. The same product is sometimes duplicated by being reported in different stages of preparation under more than one heading.

*Meat and meat food products prepared and processed under inspection.*

| Kind of product. | "Inspection pounds." | Kind of product. | "Inspection pounds." |
|---|---|---|---|
| Placed in cure: | | Lard | 1, 659, 330, 534 |
| Beef | 142, 527, 107 | Lard oil | 1, 947, 331 |
| Pork | 2, 725, 031, 285 | Lard stearin | 1, 407, 641 |
| All other | 2, 464, 508 | | |
| Sausage, chopped | 568, 626, 285 | Compound and other substitutes for lard | 312, 014, 380 |
| Canned product: | | Oleo stock and edible tallow | 63, 565, 473 |
| Beef | 90, 358, 314 | Oleo oil | 141, 938, 522 |
| Pork | 17, 645, 282 | Oleo stearin | 62, 530, 222 |
| All other | 1, 477, 613 | Oleomargarin | 118, 197, 046 |
| Sterilized product: | | Miscellaneous | 1, 473, 196, 361 |
| Beef | 2, 543, 857 | Horse meat: | |
| Pork | 8, 197, 708 | Cured | 379, 850 |
| All other | 6, 834 | Sausage, chopped | 400 |
| Pork products to be eaten uncooked | 33, 226, 453 | | |
| Meat extract | 503, 895 | Total | 7, 427, 116, 901 |

The following quantities of meat and meat food products were condemned on reinspection on account of having become sour, tainted, unclean, rancid, or otherwise unwholesome: Beef, 5,571,889 pounds; pork, 7,281,595 pounds; mutton, 125,698 pounds; veal, 41,351 pounds; goat meat, 525 pounds; horse meat, 13,130 pounds; total, 13,034,188 pounds.

### MARKET INSPECTION.

Market inspection, to facilitate interstate deliveries of meats and products, was conducted in 45 cities.

### MEAT AND PRODUCTS CERTIFIED FOR EXPORT.

The following products were certified for export: Beef and beef products, 219,981,160 pounds; pork and pork products, 1,493,793,936 pounds; mutton and mutton products, 4,308,632 pounds; total, 1,718;083,728 pounds. In addition 14 certificates were issued covering the export of 335,781 pounds of horse-meat products and 2,320 certificates covering the export of 40,339,757 pounds of inedible animal products.

### EXEMPTION FROM INSPECTION.

The provisions of the meat-inspection law requiring inspection usually do not apply to animals slaughtered by a farmer on the farm nor to retail butchers and dealers supplying their customers. The retail butchers and dealers, however, in order to ship meat and meat food products in interstate or foreign commerce, are required to obtain certificates of exemption. The number of exemption certificates outstanding at the close of the fiscal year was 2,841, an increase of 142 over the preceding year. During the year 89 certificates were canceled, 83 on account of the dealers retiring from business or ceasing to make interstate shipments and 6 for violations of the regulations.

During the year 36,477 shipments were made by retail dealers and butchers holding certificates of exemption, as compared with 34,969 shipments during the fiscal year 1921. The shipments of the year covered products as shown in the following table:

*Shipments by retail dealers and butchers under certificates of exemption from inspection.*

| Product. | Number. | Pounds. |
|---|---|---|
| Beef, carcasses (943 quarters) | 236 | 118,340 |
| Veal, carcasses | 27,346 | 2,364,057 |
| Sheep, carcasses | 797 | 37,788 |
| Swine, carcasses | 607 | 64,259 |
| Beef, fresh | | 1,068,359 |
| Veal, fresh | | 172,603 |
| Mutton, fresh | | 177,376 |
| Pork, fresh | | 266,348 |
| Cured meats | | 202,130 |
| Lard | | 17,861 |
| Sausage | | 48,634 |
| Miscellaneous (scrapple, lard substitutes, headcheese, etc.) | | 13,103 |
| Total | 28,986 | 4,550,858 |

During the year 69,815 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on the farm, as compared with 63,939 shipments in the fiscal year 1921. The following table shows the products composing these shipments:

*Shipments of farm-slaughtered products under exemption from inspection.*

| Product. | Number. | Pounds. |
|---|---|---|
| Beef, carcasses (3,591 quarters) | 898 | 260,451 |
| Veal, carcasses | 91,953 | 7,838,282 |
| Sheep, carcasses | 3,564 | 123,703 |
| Swine, carcasses | 6,126 | 679,867 |
| Beef, fresh | | 172,058 |
| Veal, fresh | | 63,395 |
| Mutton, fresh | | 2,121 |
| Pork, fresh | | 136,355 |
| Cured meats | | 381,545 |
| Lard | | 143,184 |
| Sausage | | 80,976 |
| Miscellaneous (scrapple, tripe, headcheese, etc.) | | 8,470 |
| Total | 102,541 | 9,890,407 |

## INSPECTION OF IMPORTED MEATS.

The following table shows the inspection of imported meats and meat food products for the fiscal year:

*Imported meat and meat food products inspected.*

| Country of origin. | Fresh and refrigerated meats. | | Cured and canned meats. | Other products. | Total weight. |
|---|---|---|---|---|---|
| | Beef. | Other classes. | | | |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Argentina | 622,510 | 3,727,405 | 122,527 | 489,541 | 4,961,983 |
| Australia | | 102,594 | 34 | | 102,628 |
| Brazil | 122,229 | 23,225 | 286,400 | | 431,854 |
| Canada | 15,460,528 | 13,384,106 | 104,236 | 86,416 | 29,035,286 |
| New Zealand | | 1,595,011 | 427 | | 1,595,438 |
| Uruguay | 665,155 | 101,203 | 4,455,881 | 75,457 | 5,297,696 |
| Other countries | 4,967 | 4,604 | 132,259 | 346,781 | 488,611 |
| Total | 16,875,389 | 18,938,148 | 5,101,764 | 998,195 | 41,913,496 |

The following table shows the condemnations of imported meats and the amounts refused entry on account of lack of foreign certificate or other failure to comply with the regulations:

*Imported meat products condemned or refused entry.*

| Product. | Condemned. | Refused entry. |
|---|---|---|
| | *Pounds.* | *Pounds.* |
| Beef | 1,884 | 775 |
| Veal | | 890 |
| Mutton | 14 | |
| Pork | 7,044 | 1,804 |
| Total | 8,942 | 3,469 |

### INSPECTIONS FOR OTHER BRANCHES OF THE GOVERNMENT.

By request of other branches of the Government, reinspections of meats and meat food products to determine whether they remained wholesome and conformed to certain specifications were made during the year, as shown in the following table:

*Inspections for other branches of the Government.*

| Branch of Government. | Passed. | Rejected. |
|---|---|---|
| | *Pounds.* | *Pounds.* |
| Navy Department | 68,179,403 | 3,601,222 |
| Marine Corps | 3,503,021 | 87,442 |
| War Department | 1,399,490 | |
| Interior Department (Indian Affairs) | 458,799 | 960 |
| Panama Railroad | 71,455 | 432 |
| Public Health Service | 2,766 | |
| Treasury Department (Coast Guard) | 385 | |
| Total | 73,615,319 | 3,690,056 |

### LABELING MEAT AND PRODUCTS.

A large number of labels, cartons, stencils, and other materials were submitted for approval under the regulations, and of these 19,719 were approved. The files of approved labels were carefully gone over and labels which had become obsolete were eliminated.

Correspondence was conducted and conferences were held with the committee of standards and purity of foods with a view to defining terms applicable to various products. The relabeling of large quantities of meat and meat food products was supervised, including imported meats and some 2,000,000 packages of meat and meat food products purchased from the Army.

Investigations have been begun with a view to regulating the use, in inspected establishments, of powdered milk, which, because of its water-absorbing properties, might be an adulterant of sausage and similar products.

### MEAT-INSPECTION LABORATORIES.

The laboratory examination of meats and meat food products and of substances used in connection with their preparation at establishments under inspection has been continued in the meat-inspection laboratories maintained in Washington and six other cities. The laboratories also continued to examine meat and products prepared for the Army and the Navy to determine whether they contained any harmful substances and to see that they conformed to the Army and Navy specifications.

The total number of samples analyzed during the year was 61,549, of which 61,259 were domestic and 290 imported. Samples of 2,326 domestic and 83 imported products were found not to be in accordance with the regulations. Besides meats and meat food products, the products examined consisted of curing materials, cereals, spices and condiments, coloring matter, denaturing oils, etc. Of 2,422 samples of water examined 432 were found to show evidence of pollution. All suspicious water supplies are kept under close and constant supervision.

A study of the water content of cooked and smoked sausages was made. The results show that a considerable proportion of such sausages contain water in excess of the normal amount. That the addition of excessive water is not necessary is shown by the fact that a large proportion of such sausages contained no more water than is normal to fresh meat. Measures are being taken to check the tendency to add excessive water to sausages of this class.

A study of the moisture and fat content of oleomargarin produced at inspected establishments has also been made. The results show a tendency toward a higher content of moisture with corresponding reduction in the fat content, which will require checking by appropriate regulation if continued.

Attention has been given to the matter of moisture and mold in oleo stearin with a view to reducing the spoilage through elimination of moisture in the process of manufacture.

As in previous years, all creameries preparing butter used in oleomargarin have been inspected, and lists have been issued showing those which meet the requirements with regard to pasteurization.

## FIELD INSPECTION DIVISION.

Besides continuing work in connection with the control and eradication of certain diseases of livestock and the enforcement of certain animal quarantine and transportation laws, the Field Inspection Division, under Dr. A. W. Miller, chief, on May 1 took over all the activities of the Quarantine Division following the retirement of Dr. R. W. Hickman, chief of that division, including the administration of the regulations governing the importation and exportation of livestock, and also the joint regulations of the Treasury Department and the Department of Agriculture for the sanitary handling and control of hides, skins, wool, other animal by-products, hay, straw, etc., offered for entry into the United States. The work of both divisions for the entire fiscal year is reported here.

### ERADICATION OF SCABIES.

In the eradication of scabies of sheep in cooperation with State officials, bureau employees made 24,190,956 inspections and supervised 8,869,386 dippings in the field. Livestock sanitary officials were assisted in suppressing a number of outbreaks in States where the work is not regularly carried on. While the disease is quite prevalent in a number of western range States, conditions on the whole show improvement.

Rather extensive outbreaks of cattle scabies occurred in Arizona, Utah, and Nevada, States which had previously been free from this disease. In cooperation with the livestock sanitary authorities of those States, prompt action was taken to combat the spread of infection and satisfactory progress was made in controlling the disease. In the conduct of the cooperative work in the field for the eradication of cattle scabies 1,508,924 cattle were inspected and 453,708 dippings were supervised by bureau employees.

The bureau continued to cooperate with the State livestock sanitary authorities and the Office of Indian Affairs in the suppression of an outbreak of mange in horses on the Omaha and Winnebago Indian Reservations and adjacent territory in northeastern Nebraska. In connection with this work 2,405 animals were inspected and 887 dippings supervised.

## ERADICATION OF DOURINE.

Work for the eradication of dourine of horses was continued in cooperation with State livestock sanitary authorities and the Office of Indian Affairs. Difficulties which had been encountered in rounding up and testing horses on certain Indian reservations have been largely overcome. As a result gratifying progress was made in the suppression of this disease. The disease was found largely in range herds in Arizona and to a very slight extent in South Dakota and Montana. The number of animals tested and the results of the tests are shown in the report of the Pathological Division.

## LIVESTOCK SANITARY WORK IN INTERSTATE COMMERCE.

In the course of supervising the interstate transportation of livestock to prevent the spread of animal diseases, bureau employees at market centers inspected 18,475,991 cattle, of which 11,611 were dipped under supervision in order that they might continue in interstate commerce. Sheep to the number of 20,462,270 were also inspected for communicable diseases, and of these 1,059,801 were dipped under bureau supervision to comply with the regulations of the department or of the States at destination. Bureau employees also supervised the immunization and disinfection against hog cholera of 393,295 swine for shipment to country points for feeding and breeding purposes.

On request of transportation companies and shippers or to comply with laws of States to which shipments were destined, bureau veterinarians inspected 10,085 horses and mules, of which 4,082 were tested with mallein, none showing reaction.

Bureau employees supervised the cleaning and disinfection of 39,044 cars in compliance with department regulations or on request of Canadian Government officials, State officials, or transportation companies. Of these cars, 15,112 had been used in the transportation of animals affected with communicable diseases.

All ruminants and swine received at public stockyards were carefully inspected for foot-and-mouth disease by experienced veterinary inspectors specially assigned to that work, as has been the practice for a number of years, in order that there might be no delay in the control and eradication of the disease should an outbreak occur. No cases were detected.

### ENFORCEMENT OF TRANSPORTATION AND QUARANTINE LAWS.

The bureau has continued to report to the Solicitor of the department, for presentation to the proper officials of other departments, cases of apparent violations of livestock transportation and quarantine laws. Many of these cases have required special investigations on the part of bureau employees, such as interviewing witnesses and examining railroad and other records. Four bureau employees were regularly assigned to this service, although the greater part of the work of collecting evidence and preparing and submitting reports is done by bureau employees at stockyard centers in connection with their other duties.

The enforcement of the so-called 28-hour law has resulted in better facilities being provided for the feeding, watering, and handling of livestock in transit.

### INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

The alarming prevalence of serious livestock diseases in various countries of the world has made necessary continued exercise of every possible precaution to prevent their introduction into the United States. One or more diseases such as rinderpest, contagious pleuropneumonia, foot-and-mouth disease, and surra exist in most countries of South America and the Eastern Hemisphere, rendering cattle, sheep, goats, and swine from continental Europe, Asia, Africa, and South America ineligible for importation. Cattle from the Channel Islands and from Scotland were permitted importation during the late summer and autumn of 1921, and in the early winter a small number of cattle and sheep from England were imported, Great Britain having been at that time free from foot-and-mouth disease for a period of about three months. The disease having reappeared in England and extended to Scotland in January, 1922, no cattle, sheep, other ruminants, or swine were permitted importation during the last six months of the year from any of the British Isles.

Forty-six purebred milk goats originating in Switzerland were imported from Cuba subject to inspection and the customary quarantine at the port of entry. Twenty breeding sheep from New Zealand were imported at San Francisco. Bureau employees at border ports of entry inspected and supervised the quarantine of 37,953 quail from Mexico under requirements of the Bureau of Biological Survey.

Foxes imported for breeding purposes have been permitted importation only when found on inspection to be free from various internal parasites, mange, distemper, or other diseases contagious to foxes. During the year 1,177 foxes were inspected at various ports of entry.

The following tables show importations of various kinds of live-stock through the different ports of entry:

*Imported animals inspected and quarantined.*

| Port of entry. | Cattle. | Sheep. | Swine. | Goats. | Other animals. |
|---|---|---|---|---|---|
| New York | 250 | 20 | 4 | 10 | 1,200 |
| Boston | 37 |  |  |  | 18 |
| Baltimore |  |  |  |  | 11 |
| San Francisco |  | 20 |  |  | 11 |
| Los Angeles |  |  |  | 11 |  |
| New Orleans |  |  |  | 25 | 14 |
| San Juan |  |  |  | 4 | 26 |
| Savannah |  |  |  |  | 1 |
| Seattle |  |  |  | 2 | 1 |
| Portland, Oreg |  |  |  |  | 8 |
| Canadian border ports | 602 | 3 | 57 |  | 104 |
| Total | 889 | 43 | 61 | 52 | 1,394 |

*Imported animals inspected but not quarantined.*

| Port of entry. | Cattle. | Sheep. | Swine. | Goats. | Horses. | Other animals. |
|---|---|---|---|---|---|---|
| New York |  |  |  |  | 345 |  |
| Boston |  |  |  |  | 33 | 9 |
| Baltimore |  |  |  |  |  | 1 |
| New Orleans |  |  |  |  |  | 12 |
| Seattle |  |  |  |  |  | 2 |
| San Francisco |  | 20 |  |  |  | 947 |
| Key West |  |  |  |  | 63 |  |
| San Juan, P. R | 299 |  |  |  | 84 |  |
| Mayaguez, P. R | 27 |  |  |  | 26 |  |
| Portland, Oreg |  |  |  |  |  | 28 |
| Miami, Fla |  |  |  |  | 16 |  |
| Tampa, Fla |  |  |  |  | 1 |  |
| Mexican border ports | 43,538 | 8,063 | 550 | 757 | 4,082 | 36 |
| Canadian border ports | 133,008 | 89,241 | 2,518 | 21 | 7,317 | 1,522 |
| Total | 176,872 | 97,324 | 3,068 | 778 | 11,967 | 2,557 |

Owing to suspended importations of cattle from Great Britain, the inspector assigned to London during the preceding year for the special purpose of applying the tuberculin test to cattle prior to their shipment to the United States was transferred to the United States in June. During the year 264 cattle were tested in Great Britain and the Channel Islands, with the following results:

*Tuberculin tests of cattle in Scotland and the Channel Islands for importation into the United States.*

| Breed. | Tested. | Passed. | Rejected. |
|---|---|---|---|
| Ayrshire | 16 | 12 | 4 |
| Guernsey | 1 | 1 |  |
| Hereford | 1 |  | 1 |
| Jersey | 234 | 234 |  |
| Shorthorn | 12 | 12 |  |
| Total | 264 | 259 | 5 |

## IMPORTATION OF ANIMAL BY-PRODUCTS.

While importers of hides, skins, other animal by-products, etc., have apparently made an effort to obtain their supplies from countries or sections where sanitary conditions are such that the materials may be imported into the United States without disinfection after arrival, about 10 per cent of the hides and 40 per cent of the goatskins imported during the year were uncertified and hence could be admitted only subject to disinfection at tanneries in this country. During the year goatskins and deerskins were forwarded for disinfection to 69 establishments in various parts of the country, and 33 tanneries and other establishments received for disinfection hides, calfskins, hair, wool, and glue stock.

## INSPECTION OF ANIMALS FOR EXPORT.

As in former years, careful attention has been given to the administration of the regulations of the department governing the inspection, humane handling, and safe transport of export animals and to the inspection and testing of export livestock and the issuance of certificates to meet requirements of receiving countries. In accordance with an agreement between the bureau and the Canadian veterinary director general the list of practicing veterinarians in the United States registered with authority to apply the mallein test to horse stock intended for shipment to Canada was abolished on May 1, and provision was made for the mallein testing of horses in these cases by veterinarians accredited for testing accredited herds of cattle for tuberculosis, their certificates to be indorsed by a bureau inspector.

Statistics of the inspection of animals for export are given in the following table:

*Inspections of animals for export.*

| Kind of animals. | To Canada. | To other countries. | | Total. |
|---|---|---|---|---|
| | | American animals. | Canadian animals.[1] | |
| Cattle | 1,041 | 29,991 | 8,714 | 39,746 |
| Sheep | 9,662 | 693 | | 10,355 |
| Swine | 111 | 84 | | 195 |
| Goats | 80 | 1 | | 81 |
| Horses | 1,404 | 1,757 | 9 | 3,170 |
| Mules | 73 | 895 | | 968 |
| Total | 12,371 | 33,421 | 8,723 | 54,515 |

[1] Animals of Canadian origin exported through United States ports.

Inspections of 224 vessels carrying livestock were made before clearance.

The mallein test was applied to 1,404 horses and 73 mules for shipment to Canada. Of the 1,041 cattle shipped to Canada, 236 were beef animals destined to England and Scotland and, therefore, were not tested with tuberculin. Of the number tested there were three reactors. For shipment to other countries, including Mexico and Cuba, 4,064 cattle were tested with tuberculin, with 19 reactors. The mallein test was applied to 131 horses.

## TICK ERADICATION DIVISION.

Further progress was made in the work conducted by the Tick Eradication Division, under Dr. R. A. Ramsay, chief, for the suppression of Texas or tick fever of cattle and the eradication of the ticks which transmit this disease.

### TICK ERADICATION.

As a result of the work done in cooperation with the authorities of various Southern States for the extermination of the cattle ticks, areas aggregating 29,563 square miles were released from quarantine during the fiscal year. This action makes available 42 additional counties and 7 parts of counties into which better-bred cattle from tick-free States may be taken without danger of loss from tick fever. The result, as shown in areas previously freed of ticks, is an increase in meat and dairy products and an improvement in grade of cattle hides to a degree which renders them from 20 to 50 per cent more valuable.

The total area released from quarantine since the beginning of this work, in 1906, and remaining free at the close of the fiscal year, amounts to 523,837 square miles, or close to 72 per cent of the 729,852 square miles originally infested.

The following table shows, by States, the territory released during the last fiscal year:

*Areas released from quarantine as a result of eradicating cattle ticks, fiscal year 1922.*

| State. | Square miles. |
|---|---|
| Georgia | 5,873 |
| Louisiana | 1,946 |
| North Carolina | 517 |
| Texas | 21,227 |
| Total | 29,563 |

The continued presence and spread of ticks in certain areas that had previously been released from quarantine made it necessary to requarantine some counties and parts of counties in order to protect tick-free areas in adjacent counties and States from reinfestation. This condition arose from the failure of local officials, because of lack of funds, to maintain quarantine over the few remaining tick-infested herds and to complete the eradication of ticks in the released areas. In nearly every case, however, the requarantine has had the desired effect, and ways and means have been found by local officers and cattle owners to finish the work.

During the year 48,089,005 inspections or dippings were made of cattle for the eradication of ticks, as compared with 34,935,635 in the preceding year. There were in operation 31,148 cattle-dipping vats where cattle were dipped under Federal or State inspection to rid them of ticks. As an indication that the dipping of cattle is not attended by any great loss or danger, it may be stated that the fatalities from dipping were only 7 per million cattle dipped and handled, besides which only 5 per million were injured.

In the territory already released from quarantine there remain here and there a few infested premises or centers of tick infestation which must be held under control until the last tick can be put out of existence. This condition, taken in conjunction with the effort to eradicate ticks from additional areas still under Federal quarantine, means that Federal and State funds have to be spread very thinly over a very large territory. It is therefore difficult to concentrate efforts in certain areas to such a degree as was done a few years ago. The cost of tick eradication is much greater than it was then and less can be accomplished with the same appropriation. County appropriations will have to be greatly increased if satisfactory results are to be obtained.

Independence County, Ark., has furnished an example of the obstacles and difficulties sometimes encountered in tick eradication in certain areas. In that county, where tick eradication was far advanced, an inspection of cattle in March, 1922, showed general tick infestation in an area of approximately 400 square miles and that local inspectors were neither dipping the cattle nor reporting the refusal of the cattle owners to dip. Accordingly the county authorities were requested to procure dipping material and employ men to dip the cattle. The first week that these county men were assigned to duty two of them were shot from ambush, one being killed and the other seriously wounded. Unknown persons then posted notices throughout this area and at dipping vats to the effect that any person who came into that portion of the county to enforce cattle dipping would receive similar treatment. The result was that all county inspectors stopped work.

To meet this condition of opposition to State law, a number of young men who had seen military service abroad and who were not residents of that county were selected and properly equipped with means of defense and with horses, camps, bedding, and every facility for protecting themselves as well as Federal, State, and county property. These men could not obtain board locally, as any person who would take them in was threatened with the destruction of his residence and property, and consequently they had to live in camps. All the dipping vats had been dynamited by the outlaw element, and it was necessary for the county to construct a dipping vat, which was placed under the protection of these employees. The ex-service men chose to ride in a formation known as "threes," two ahead and one some distance in the rear, in order to avoid an attack from ambush. In this formation the men regularly called on every cattle owner and instructed him to have all his cattle at this one dipping vat on a certain date at a certain hour, and further notified him that if the cattle were not there it would be their duty to come and get them at his expense. As a result of this plan all cattle in that area have been dipped regularly every 14 days since the first of May up to the time of closing this report. No further attacks or fatalities have occurred, and it is believed that by this means tick eradication can be completed in an area where systematic dipping was previously considered impossible.

### SHIPMENTS FROM QUARANTINED AREAS.

The number of cattle of the quarantined area shipped under bureau supervision to market centers for immediate slaughter was 453,985, which is a considerable decrease from the preceding year. Many cattle owners in tick-eradication localities have shown a disposition to ship for slaughter as many unprofitable cattle as possible in preference to dipping them. This was done with a view of procuring, after ticks are eradicated, better-bred animals likely to be more profitable for breeding purposes. At public stockyards 90,077 cattle were dipped and certified for movement as noninfected, for which 742 certificates were issued. At points other than public stockyards, in areas where cattle are regularly dipped to eradicate ticks, 90,618 cattle were inspected or dipped and certified for interstate movement as noninfected, as provided for in the regulations. To cover the shipments of these cattle 520 certificates were issued.

## TUBERCULOSIS ERADICATION DIVISION.

The results obtained in the work for the control and eradication of bovine tuberculosis, conducted by the Tuberculosis Eradication Division under the direction of Dr. J. A. Kiernan, chief, affords many sources for gratification. The 5-year period ending with this fiscal year was largely one of organization, and the past year, in addition to the results obtained in the actual testing of cattle, was largely devoted to solidifying cooperation among the many parties interested, namely, the State livestock authorities, practicing veterinarians, farm bureau agencies, livestock breeders' associations, public health officials, and others. With few exceptions the spirit of harmony and cooperation existing between these forces and the bureau is all that could be expected under the circumstances and in the period of time which has elapsed since organizing the work. In addition much has been done toward gathering the necessary data and statistics upon which plans for the complete eradication of tuberculosis in livestock in the various States and smaller county units must be based. The data which are probably of most value pertain to the incidence of the disease in every county in the United States. It appears that in 46.4 per cent of the total area of the United States, containing 41.2 per cent of all the cattle in the country, only 0.6 per cent of the cattle are tuberculous. This is contradictory to the impression which has probably existed that a majority of the cattle in the country are found in the areas known to be more or less heavily infected. As a matter of fact only 15.3 per cent of the cattle of the country in 5.5 per cent of the entire area are regarded as being badly diseased, these figures representing areas containing more than 10 per cent of diseased cattle.

The data used in compiling these figures were furnished by bureau and State officials in each State and were based upon their knowledge of conditions in each county as evidenced by actual tuberculin tests and by other relatively accurate means of estimation. A close study of these figures warrants the belief that with a continuation of present progress it should be practicable to render a number of States practically free from the disease before many more years have elapsed. In fact, plans have been drafted for the conduct of the work in many States with a view to the complete eradication of the disease within the next five years.

Cooperation was extended during the year to include all the 48 States and the Territories of Hawaii and Alaska. The last States to provide the necessary legislation and funds were New Mexico, Arizona, and California. Field offices are maintained by the bureau in 43 cities in as many States. An average of 247 regularly employed veterinary inspectors were detailed to these offices during the year, and they were supplemented by an average of 172 State inspectors and an average of 38 county, city, or farm bureau veterinarians.

Despite increased appropriations by Congress, the available funds were insufficient for pressing the work as rapidly as was desired by herd owners. At the close of the fiscal year 35,239 herds, comprising approximately 508,128 cattle, were on the waiting list for future testing, as compared with 14,440 herds containing 216,000 cattle a year previously.

In accordance with the practice established in previous years, the activities were carried on under four main projects: (1) Eradication of tuberculosis from purebred herds of cattle under the "Accredited-herd" plan; (2) eradication of tuberculosis from circumscribed areas; (3) eradication of tuberculosis from swine; (4) control of the tuberculin testing of cattle intended for interstate shipment through supervision of the work done by practicing veterinarians on the approved list and at public stockyards.

### ACCREDITED TUBERCULOSIS-FREE HERDS.

The plan for the eradication of tuberculosis from herds of purebred cattle and maintaining a list of such herds officially accredited as being free from tuberculosis was slightly modified at the meeting of the United States Live Stock Sanitary Association in November, 1921, so as to make larger use of accredited practicing veterinarians and thus to expedite the testing. Such practitioners may now, under the direction of State authorities, apply the tuberculin test to herds undergoing original tests at the expense of the owners and without obligating the Federal Government for indemnity.

At the conclusion of the fiscal year there were under supervision 212,182 herds containing 2,616,395 cattle, an increase of 140,376 herds and 1,420,598 cattle within the year. In other words, the work was more than doubled during the year. These figures, however, include the area work, which will be reported under another heading. The number of cattle to which the tuberculin test was applied was 2,384,236, of which 82,569, or 3.5 per cent, were condemned as diseased. At the close of the fiscal year there were 16,216 fully accredited herds containing 363,902 cattle, as against 8,201 herds containing 193,620 cattle a year previously. In addition 161,533 herds containing 1,548,183 cattle passed one test as a preliminary to being accredited, as compared with 49,814 herds and 643,233 cattle a year before. The accompanying table shows by States the number of accredited herds and cattle and the number of herds and cattle that have passed one test:

*Herds of cattle accredited as free from tuberculosis and herds that have passed one test up to June 30, 1922.*

| States. | Accredited. | | Passed 1 test. | |
|---|---|---|---|---|
| | Herds. | Cattle. | Herds. | Cattle. |
| Alabama | 79 | 3,458 | 735 | 17,444 |
| Arkansas | 35 | 1,084 | 39 | 845 |
| California | 0 | 0 | 129 | 1,370 |
| Colorado | 1 | 37 | 7 | 269 |
| Connecticut | 83 | 2,180 | 475 | 8,613 |
| Delaware | 125 | 1,470 | 1,120 | 4,690 |
| District of Columbia | 194 | 815 | 141 | 345 |
| Florida | 88 | 3,113 | 3,133 | 23,865 |
| Georgia | 21 | 1,558 | 1,812 | 26,523 |
| Idaho | 116 | 4,031 | 5,056 | 40,454 |
| Illinois | 368 | 8,589 | 709 | 12,740 |
| Indiana | 1,308 | 22,326 | 8,970 | 62,290 |
| Iowa | 779 | 23,649 | 3,500 | 51,690 |
| Kansas | 388 | 11,800 | 395 | 10,500 |
| Kentucky | 194 | 5,500 | 5,347 | 41,273 |
| Louisiana | 63 | 2,681 | 516 | 11,542 |
| Maine | 523 | 6,413 | 6,748 | 56,203 |
| Maryland | 386 | 7,572 | 1,632 | 16,698 |
| Massachusetts | 61 | 2,350 | 68 | 1,930 |
| Michigan | 385 | 7,642 | 13,496 | 113,519 |
| Minnesota | 1,506 | 34,833 | 2,022 | 38,759 |
| Mississippi | 140 | 3,241 | 352 | 11,026 |
| Missouri | 389 | 12,400 | 18,703 | 177,465 |
| Montana | 116 | 6,358 | 9,914 | 126,466 |
| Nebraska | 210 | 5,877 | 7,728 | 95,390 |
| Nevada | 7 | 882 | 1,517 | 8,873 |
| New Hampshire | 65 | 1,717 | 485 | 5,111 |
| New Jersey | 73 | 2,007 | 112 | 1,693 |
| New Mexico | 0 | 0 | 724 | 5,575 |
| New York | 565 | 12,380 | 4,511 | 53,615 |
| North Carolina | 277 | 5,604 | 20,988 | 81,545 |
| North Dakota | 721 | 15,962 | 3,593 | 63,037 |
| Ohio | 848 | 15,416 | 1,523 | 17,774 |
| Oklahoma | 182 | 6,334 | 391 | 9,327 |
| Oregon | 170 | 4,144 | 9,163 | 90,987 |
| Pennsylvania | 1,165 | 19,501 | 1,039 | 14,598 |
| Rhode Island | 14 | 304 | 17 | 544 |
| South Carolina | 80 | 2,639 | 882 | 10,875 |
| South Dakota | 218 | 4,733 | 293 | 7,600 |
| Tennessee | 198 | 7,623 | 669 | 13,020 |
| Texas | 66 | 2,211 | 46 | 1,714 |
| Utah | 77 | 2,457 | 6,238 | 21,994 |
| Vermont | 1,165 | 17,675 | 2,460 | 35,573 |
| Virginia | 675 | 15,792 | 1,300 | 14,407 |
| Washington | 111 | 2,871 | 5,687 | 43,869 |
| West Virginia | 224 | 4,828 | 2,029 | 17,337 |
| Wisconsin | 1,754 | 39,735 | 2,345 | 49,505 |
| Wyoming | 3 | 110 | 2,774 | 27,701 |
| Total | 16,216 | 363,902 | 161,533 | 1,548,183 |

The large increase in testing is due in a measure to the participation of the accredited practicing veterinarians who were delegated to retest herds which had been freed from tuberculosis and to the interest generally displayed by this group of men. As a result of examinations the number of accredited veterinarians was increased from 3,160 on June 30, 1921, to 4,412 at the close of this fiscal year.

### ERADICATION OF TUBERCULOSIS FROM AREAS.

The eradication of tuberculosis from livestock by means of the tuberculin testing of all cattle within a given area is the predominating work of the State and bureau forces. This plan has now advanced beyond the experimental stage.

At the close of the fiscal year 31 counties had completed one or more tests of all the cattle within their borders (7 in Oregon, 4 each in Washington and Wisconsin, 3 each in Michigan and Mississippi, 2 each in Montana and Nebraska, and 1 each in Idaho, New York, North Carolina, Utah, Virginia, and West Virginia), while campaigns were actively under way in 138 other counties, and in 296 additional counties preliminary work was being done.

The area testing in the District of Columbia was continued. There were inspected or tested 345 herds containing 1,166 cattle, from which were removed 2 reactors, or 0.17 per cent. In order to accommodate the dealers bringing cattle into the District of Columbia, a part of Union Stockyards at Benning, D. C., was set apart for the testing of cattle and given recognition as a public stockyard. At this point there were tested 107 lots of cattle containing 193 head from which 6 reactors were removed.

### STATISTICS OF SLAUGHTER AND INDEMNITY.

Statistics of the slaughter of reacting cattle, the indemnity allowed, salvage realized, etc., are shown in the following table:

*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication.*

| State. | Number of cattle. | Average appraisal per head. | State indemnity. | Federal indemnity. | Average State indemnity per head. | Average Federal indemnity per head. | Average salvage per head. |
|---|---|---|---|---|---|---|---|
| Alaska | 25 | $167.60 | $1,335.13 | $605.42 | $53.41 | $24.22 | $19.67 |
| Colorado | 31 | 437.10 | 1,416.13 | 1,416.13 | 45.68 | 45.68 | 26.07 |
| Connecticut | 3,172 | 60.85 | 92,289.81 | 46,999.82 | 29.10 | 14.82 | 16.38 |
| Delaware | 916 | 99.46 | 35,863.53 | 19,810.18 | 38.06 | 21.63 | 13.77 |
| Florida | 263 | 28.64 | 2,755.15 | 1,351.79 | 10.47 | 5.14 | 12.93 |
| Hawaii | 88 | 216.25 | 10,426.57 | 2,001.38 | 118.48 | 22.74 | 49.43 |
| Idaho | 370 | 90.09 | 7,718.82 | 7,718.82 | 20.86 | 20.86 | 19.92 |
| Illinois | 1,883 | 138,01 | 61,236.32 | 61,236.32 | 32.52 | 32.52 | 25.19 |
| Indiana | 2,890 | 107.03 | 78,288.78 | 66,184.37 | 27.09 | 22.90 | 20.74 |
| Iowa | 5,078 | 128.17 | 148,824.75 | 129,003.80 | 29.31 | 25.40 | 19.72 |
| Kansas [1] | 604 | 137.73 | 39,030.22 | 17,572.90 | 64.62 | 29.09 | 23.32 |
| Kentucky | 890 | 88.97 | 44,425.63 | 17,339.94 | 49.92 | 19.48 | 11.64 |
| Maine [1] | 801 | 97.13 | 49,567.81 | 17,739.38 | 61.88 | 22.15 | 10.69 |
| Maryland | 1,571 | 81.38 | 35,364.84 | 35,364.84 | 22.51 | 22.51 | 13.59 |
| Massachusetts | 43 | 124.30 | 2,525.00 | 972.37 | 58.72 | 22.61 | .22 |
| Michigan | 4,282 | 87.48 | 187,187.37 | 90,602.53 | 43.71 | 21.16 | 16.24 |
| Minnesota | 2,216 | 56.27 | 55,798.81 | 28,135.98 | 25.18 | 12.70 | 18.11 |
| Mississippi | 95 | 60.37 | 2,770.44 | 1,538.94 | 29.16 | 16.20 | 7.96 |
| Missouri | 1,698 | 115.97 | 40,164.36 | 40,164.36 | 23.65 | 23.65 | 23.96 |
| Montana [1] | 800 | 64.92 | 36,040.51 | 15,006 73 | 45.05 | 18.76 | 7.31 |
| Nebraska | 1,955 | 90.54 | 38,101.90 | 38,101.34 | 19.49 | 19.49 | 21.85 |
| Nevada | 296 | 75.18 | 11,772.65 | 7,077.98 | 39.77 | 23.91 | 11.03 |
| New Hampshire | 940 | 105.66 | 39,691.90 | 20,769.09 | 42.23 | 22.09 | 17.08 |
| New Jersey | 1,093 | 287.52 | 69,775.80 | 39,162.02 | 63.84 | 35.83 | 23.87 |
| New Mexico | 74 | 45.66 | 1,201.33 | 1,201.33 | 16.23 | 16.23 | .......... |
| New York | 5,905 | 145.13 | 450,341.24 | 196,154.57 | 76.26 | 33.22 | 15.10 |
| North Carolina | 461 | 121.18 | 10,479.06 | 10,479.06 | 22.73 | 22.73 | 19.03 |
| North Dakota | 1,333 | 46.87 | 13,769.51 | 13,769.51 | 10.33 | 10.33 | 15.87 |
| Ohio | 1,203 | 135.11 | 40,875.53 | 40,875.53 | 33.97 | 33.97 | 26.94 |
| Oklahoma | 377 | 115.96 | 19,739.32 | 10,784.66 | 52.36 | 28.60 | 10.00 |
| Oregon | 622 | 112.39 | 16,263.53 | 16,261.23 | 26.15 | 26.14 | 15.37 |
| Pennsylvania | 387 | 191.92 | 20,030.17 | 13,263.30 | 51.76 | 34.27 | 20.47 |
| Rhode Island | 92 | 192.88 | 6,386.65 | 3,172.98 | 68.33 | 34.48 | 29.16 |
| South Carolina | 221 | 63.38 | 3,340.90 | 3,340.90 | 15.13 | 15.13 | 18.00 |
| South Dakota | 642 | 137.69 | 27,569.51 | 15,934.29 | 33.59 | 24.66 | 20.91 |
| Tennessee | 46 | 255.43 | 4,391.67 | 2,086.06 | 93.29 | 45.34 | 21.14 |
| Texas | 454 | 198.22 | 16,191.54 | 16,090.77 | 35.66 | 35.42 | 17.85 |
| Utah | 297 | 103.12 | 6,175.88 | 6,175.88 | 20.79 | 20.79 | 12.32 |
| Vermont | 3,679 | 76.53 | 78,282.74 | 78,282.54 | 21.27 | 21.27 | 11.71 |
| Virginia | 616 | 119.02 | 21,037.88 | 16,138.29 | 34.15 | 26.19 | 14.40 |
| Washington | 1,356 | 124.59 | 32,696.18 | 32,696.15 | 23.37 | 23.37 | 22.70 |
| West Virginia | 367 | 81.46 | 16,425.02 | 8,260.29 | 44.80 | 22.50 | 9.31 |
| Wisconsin | 4,264 | 133.38 | 105,812.80 | 101,806.66 | 24.32 | 23.87 | 17.73 |
| Wyoming | 159 | 108.07 | 3,982.93 | 3,638.58 | 25.05 | 22.88 | 13.78 |
| Total | 54,555 | 110.90 | 1,987,365.62 | 1,296,289.01 | 36.43 | 23.76 | 17.55 |

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[1] Salvage paid to State.

### ERADICATION OF TUBERCULOSIS FROM SWINE.

It is generally accepted that probably 90 per cent of all tuberculosis in swine is from cattle sources. It can thus be readily understood that the ultimate control and eradication of tuberculosis in swine depends upon its eradication from cattle. It is therefore believed that freeing areas from bovine tuberculosis will reduce to the ultimate minimum the per cent found in swine. Attention was given to tracing the sources of infection in hogs which were found affected with tuberculosis when slaughtered at establishments under Federal meat inspection.

### INSPECTION AND TESTING FOR INTERSTATE MOVEMENT.

The list of veterinary practitioners authorized to make tuberculin tests of cattle for interstate shipment has been increased to 8,010 names. The work of these men has shown improvement. They tested 149,548 cattle, of which 2,777, or 1.8 per cent, were reactors.

Regularly employed bureau inspectors tested at public stockyards or at other official stations 35,485 cattle, from which there were removed 653 reactors, or 1.8 per cent.

In accordance with the regulation requiring that a permit be issued for the interstate movement of known tuberculous cattle for immediate slaughter or for return to the original owner for breeding purposes, permits were issued covering 25,706 reactors for slaughter and 35 for return to owners. Such movement often makes available better marketing facilities and better prices, thus lessening the amount of State and Federal indemnities required.

### TUBERCULIN TESTING.

The large number of cattle tested with tuberculin during the past year (2,384,236) afforded an excellent opportunity for the veterinarians to improve their knowledge of the various forms of the tuberculin test and for the bureau to standardize methods throughout the service.

Statistics of tests by the various methods are as follows: Subcutaneous method, 156,365 cattle, with 7,507 reactors, or 4.8 per cent; intradermic method, 1,738,207 cattle, with 57,029 reactors, or 3.3 per cent; ophthalmic method, 2,814 cattle, with 116 reactors, or 4.1 per cent; combination tests, 445,136 cattle, with 17,605 reactors, or 4 per cent. The demand for area testing is largely responsible for the extensive use of the intradermic method. Retests by other methods following this method have confirmed its reliability. Further experience with the various tests shows that all are valuable and reliable when used according to circumstances.

Bureau inspectors tested 53 per cent of the total herds tested, 55 per cent of the total cattle, and obtained 49.5 per cent of the total reactors.

Investigations regarding the incidence of tuberculosis in calves showed that approximately 4 per cent of the calves were infected. Without the use of the intradermic method of testing these animals would have been permitted to remain in the herds.

The average cost of testing by bureau inspectors, including salaries and expenses of field veterinarians, but not office expenses or salaries of supervising officers, was 46 cents a head, as compared with 57 cents for the preceding year.

Close supervision was again given to the slaughter of reacting cattle with a view to investigating the cases in which no visible lesions of tuberculosis were found on post-mortem examination. Of 42,770 reactors slaughtered, 3.3 per cent showed skin lesions only and 1 per cent showed udder lesions, while 62 varieties of other obscure lesions were reported. A close study of all these reactors indicates that approximately 17.8 per cent would be classified as spreaders of the disease, and that approximately 12 per cent were either condemned or sterilized as unfit for food purposes.

### CONFERENCES, PUBLICITY, ETC.

Two major conferences on tuberculosis eradication were held during the year, one at Chicago, Ill., November 25 and 26, 1921, and one at Hartford, Conn., June 6 to 8, 1922. These conferences included bureau and State officials, veterinary employees, practicing veterinarians, livestock owners, representatives of breeders' associations, public-health officials, county agents, and others. Representatives of the Tuberculosis Eradication Division also attended other conferences of veterinarians, livestock owners, public officials, and others.

A conference of bureau inspectors in charge was held at Washington in September, 1921, for the purpose of revising and improving the methods of keeping field office records. Considerable improvement in efficiency has resulted.

The distribution of literature is an important means of promoting the eradication of tuberculosis from livestock. A large distribution of Farmers' Bulletin 1069 has been maintained. A poster, "Fight Tuberculosis," was issued and has been well received. Mimeographed circulars were sent at intervals to bureau veterinarians and accredited practitioners with a view to improving and standardizing their methods and cultivating their interest and cooperation. Twenty-three articles on tuberculosis eradication were prepared in the division and published in livestock and veterinary periodicals.

## DIVISION OF HOG-CHOLERA CONTROL.

Activities in combating hog cholera were continued through the Division of Hog-Cholera Control, under Dr. U. G. Houck, chief, in cooperation with State authorities in 32 States.

Early in the year extensive outbreaks of hog cholera occurred in a few of the Cotton Belt and Corn Belt States. Owing to financial conditions farmers did not buy the necessary serum to immunize their swine, and before steps could be taken to check these outbreaks some serious losses had been experienced.

These circumstances no doubt account for the increased death rate from the disease, which rose from 39.3 per 1,000 in the year ended April 30, 1921, to 48.7 per 1,000 in the following year. This experience emphasizes the necessity for continued vigilance and action to cope with the disease and shows that cholera continues to be the most serious menace to the swine industry if not guarded against constantly.

Approximately 80 veterinarians were maintained in the field for the entire year. In localities where the services of veterinary practitioners were not available bureau inspectors continued to apply the preventive serum treatment in infected herds and to immunize exposed animals. Where veterinary practitioners were available, bureau activities consisted in the investigation of reported outbreaks, diagnosing swine diseases, assisting the local veterinarians in diagnosing and in treating herds in cases of cholera, and advising farmers as to cleaning and disinfecting premises and the proper care of swine herds.

In the course of their activities bureau veterinarians attended 1,074 meetings at which 67,408 persons were present, and 4,343 demonstrations in the use of the serum treatment were given before a total of 26,428 farmers and others. At these demonstrations 88,846 hogs were treated. Investigations were made on 47,137 premises, 5,390 autopsies were held, and cholera was diagnosed in 4,079 cases. A total of 1,401 infected premises were quarantined or carded, 439 places were cleaned and disinfected, 171,325 persons interested in hog production and the control of hog cholera were interviewed, and 36,787 hogs were treated in connection with the efforts to assist practicing veterinarians and improve their technic.

The year brought about a marked change in the attitude of veterinarians and others regarding the diagnosis of swine ailments allied with hog cholera. Farmers and practitioners alike have realized that hog cholera is still the predominant disease affecting swine herds and that the serum treatment is the most reliable agent for protection against losses. There are still many veterinary practitioners, however, who need to exercise more care in the handling of serum and virus, in their technic of administration, in the use of the thermometer, and in learning the history of cases.

The fine spirit of cooperation shown by the extension divisions of State agricultural colleges is gratifying. Through the vigilance and cooperation of county agents many outbreaks of hog cholera were reported to bureau and State veterinarians, thus making it possible for them to give assistance to swine owners early in the development of the disease and before serious losses had occurred.

## PATHOLOGICAL DIVISION.

The Pathological Division, under the direction of Dr. John S. Buckley, chief, has continued the scientific investigation and diagnosis of animal diseases, the testing of biological products manufactured and marketed under Federal control, and the study of plants poisonous to livestock.

### RESEARCH ON DISEASE PROBLEMS.

#### BOVINE INFECTIOUS ABORTION.

Endeavors have been continued to acquire further information relative to the value of biological preparations for controlling abortion losses. Studies in infected herds have indicated that living-abortion organism vaccine may be employed advantageously in conjunction with sanitary measures. The degree of immunity conferred appears to be relative and not absolute, and frequently incapable of protecting subjects against excessive exposure to infection.

Under experimental conditions localization of the infection in the udders of milking cows has in rare instances appeared to follow the administration of the treatment, a feature which has caused some doubt as to the advisability of treating subjects other than unbred heifers. The object of vaccination has been regarded as being defeated when udder infection is occasioned, as much uncertainty then exists as to the outcome of every pregnancy so long as the condition persists. Further work directed toward acquiring more information relative to this feature has indicated that udder infection resulting from subcutaneous injections of vaccine may possibly not occur with sufficient frequency to render the procedure highly objectionable.

Living-abortion organism vaccine has given indication up to the present time of being merely preventive in action. Animals in which *Bacterium abortus* infection is present at time of treatment are considered as deriving little or no benefit. It has, moreover, seemed reasonable to assume that vaccination constitutes an illogical procedure in connection with animals which have previously acquired the disease but no longer harbor the infection in their bodies. Their resistance to reinfection is probably greatly in excess of the degree than can be imparted to susceptible subjects by the treatment.

Routine work, as usual, has demanded considerable attention. More than 2,000 samples of blood serum were subjected to the agglutination test. The results obtained have frequently enabled cattle owners promptly to take appropriate control measures. Correspondence has furnished a means of disseminating information regarding control measures to those who have manifested interest in the subject.

### BOTULISM.

The active immunization of mules against botulism by means of toxin-antitoxin mixtures was successfully accomplished. Two mules were given at four-day intervals three subcutaneous injections of toxin-antitoxin mixtures in which there was a slight excess of toxin. The animals bore this treatment well, manifesting only a slight reaction. Nineteen days after the last injection one of the mules was injected with 6,000 guinea-pig minimum lethal doses of botulism toxin, and three months after the last injection of the toxin-antitoxin mixtures the second mule was likewise injected with 1.500 guinea-pig lethal doses of the toxin. No symptoms resulted in either case.

Some tests on guinea pigs showed that the passive immunity afforded by injections of large doses of botulinus antitoxin does not exceed three weeks.

### SWINE ERYSIPELAS.

The occurrence of swine erysipelas in the United States is now definitely established. During the early spring of the present year observations were made on an outbreak of a fatal disease in suckling pigs. Bacteriological study of one of the dead animals showed the presence of *Bacillus erysipelatis suis* in practically pure culture in the blood and various organs of the body. The organism in this case proved to be identical in morphological, cultural, and pathogenic properties with that isolated in this laboratory in 1920 from swine urticarial lesions.

In Europe it is a well-known fact that the swine erysipelas germ is responsible for certain types of arthritis in swine. During the last year some bacteriological work has been done on material from polyarthritis cases in swine. In one instance *Bacillus erysipelatis suis* was isolated from an infected joint.

### DIPHTHERIA ANTITOXIN IN BLOOD OF NORMAL HORSES.

It was found that about 30 per cent of serums from normal horses contained sufficient protective properties in quantities of 1 cubic centimeter to protect guinea pigs against two fatal doses of diphtheria toxin. That this protective property was due to specific antitoxin was demonstrated by the application of the Schick test to a number of horses. The results of this work were reported in the Journal of the American Veterinary Medical Association June, 1922, page 286.

### COMMERCIAL RAT VIRUSES.

Twelve commercial rat viruses were tested in caged rats both by feeding and by inoculation. A wide range of efficiency was demonstrated as between different products or different samples of a given product. In general the commercial viruses did not accomplish what was claimed for them.

A study of the Danysz bacillus, which is used in the preparation of commercial rat viruses, showed that its virulence could be enhanced in a measure by rat inoculations, and that the recovered organism, if repeatedly transferred upon ordinary media, would rapidly decrease in virulence. Feeding and inoculation tests indicated its nonpathogenicity for ordinary domestic animals and laboratory animals other than rats or mice.

### OTHER INVESTIGATIONS.

Lesions in the spleens of swine, resembling somewhat in gross appearance the lesions of tuberculosis, were studied under the microscope. The presence in some cases of small bodies closely resembling actinomyces led to the conclusion that the affection was actinomycosis.

A study of Lange's colloidal gold test applied to the spinal fluids of animals dead of various diseases was made, with particular attention to dourine. A variety of curves were obtained, many of which, however, bore considerable similarity.

Stock cultures of more than 100 microorganisms are maintained in the Pathological Division for the purpose of supplying the needs of biological houses, research workers, and educational institutions.

## INVESTIGATIONS OF CHANGES IN MEATS.

In the last annual report reference was made to a condition observed in pork hams, particularly cooked hams, in which there was a complete breaking down of the musculature, resulting in a soft, pasty condition. Microscopical examination disclosed the presence of numerous small parasites (sarcosporidia). In a large percentage of such cases the only diseased condition accompanying the heavy parasitic infestation was a very marked degeneration of the muscle tissue, thought to be due to some form of toxin eliminated by the parasites. A paper has been published giving in detail the observations made.

An investigation into the cause of the souring of hams while in the process of curing and smoking has been begun. This is a problem of considerable economic importance.

In the bacteriological examination of specimens of sour beef, *Bacillus megatherium* was found to be the cause of the condition. It was also learned that this organism would sour beef at a wide range of temperature, but not in the absence of oxygen. Propionic acid is elaborated during the bacterial process. The organism and its products were found to be harmless to rabbits and guinea pigs, by feeding as well as by injection.

## DIAGNOSIS OF DISEASES.

### RABIES.

Specimens from 100 suspected cases of rabies were received and submitted to laboratory examination. Fifty-six were positive, while in two cases decomposition prevented a diagnosis. The number of positive cases was nearly double that of the preceding year. The positive cases were 47 dogs, 6 cats, 2 cattle, and 1 hog. A number of persons, as well as dogs and other animals, were bitten by the affected animals. In addition to the cases from the District of Columbia, the material included cases from Maryland, Virginia, West Virginia, Tennessee, and New Hampshire. The regulation requiring the muzzling of dogs in the District of Columbia is in effect from July 9 to October 23, or for 107 out of 365 days, or less than one-third of the year. During the months of April, May, and June, when dogs are not muzzled, 37 cases were examined for rabies, 17 being positive. The latter figure does not represent the full extent of the infection, as a number of the cases are examined in other laboratories and in some cases the animal is destroyed without examination.

### TUBERCULOSIS.

Specimen tissues taken from 1,422 cattle which had reacted to the tuberculin test but had shown no visible lesions of tuberculosis on autopsy were examined microscopically in the laboratory, and 290 of the samples were found to contain tubercle bacilli. The finding of tubercle bacilli in skin lesions shows the importance of careful examination of the skin of reactor cattle on post-mortem examination.

A number of nodular spleens from calves from 2 to 8 weeks old were examined, and the lesions in several proved to be due to acid-fast bacilli having the size and form of bovine tubercle bacilli.

### GLANDERS.

Cooperative work in the control and eradication of glanders in the various States was continued. The complement-fixation test was applied to 159 samples of serum from animals suspected of being affected with or exposed to glanders, and only one was found to give a positive reaction.

## DOURINE.

In the course of the campaign for the control and eradication of dourine 14,549 samples of blood serum from horses in districts where dourine exists or is suspected were subjected to the complement-fixation test for that disease. Two hundred and forty-three of the samples, or 1.6 per cent, gave positive reactions.

## TESTING BIOLOGICAL PRODUCTS.

The testing of commercial veterinary biological products prepared under Government licenses, as well as of the cultures from which these products are made, has been continued, with samples submitted through the Division of Virus-Serum Control, in connection with the enforcement of the virus-serum-toxin law. One hundred and twenty samples, representing 47 different kinds of products, were examined, and 23 were found to be unsatisfactory. There were also examined 948 cultures, of which 318 were found to be either contaminated, impure, or untrue to type.

## BLACKLEG VACCINE.

During the year 1,582,375 doses of vaccine for immunizing cattle against blackleg were prepared and distributed to cattle owners and breeders. The manufacture and distribution of this vaccine by the bureau was discontinued at the close of the fiscal year, in accordance with the expressed desire of the Congress.

## POULTRY DISEASES.

The principal poultry diseases encountered in specimens submitted for examination were bacillary white diarrhea and coccidiosis in young chicks, roup and chicken pox in grown fowls, and "blackhead" in turkeys. Correspondence with poultry raisers indicates that tuberculosis is very prevalent among fowls in the northern half of the United States and particularly so in the Central and Western States. This may account for the marked increase of tuberculosis observed in pigs at slaughtering establishments, since these animals are susceptible to avian tuberculosis. The results of an investigation showed that canned goods preserved with a commercial canning mixture were poisonous to chickens. These results were published.

## AUTOPSIES ON WILD ANIMALS.

The carcasses of 28 birds and 38 mammals were received from the National Zoological Park for autopsy. Among the birds there were found 10 cases of enteritis, 1 of peritonitis, 1 of pleurisy, 2 of pneumonia, 1 of abscess of the lung, 5 of anemia, 4 of aspergillosis, and 4 of tuberculosis. In the mammals there were 7 cases of enteritis, 3 of colitis, 4 of gastroenteritis, 2 of septic peritonitis, 1 of metroperitonitis, 1 of hemorrhagic cystitis, 3 of pneumonia, 2 of verminous bronchopneumonia, 1 of pleurisy, 2 of pleuropneumonia, 3 of septicemia, 4 of anemia, and 5 of tuberculosis.

## INVESTIGATION OF POISONOUS PLANTS.

In the investigation of poisonous plants and their effects on livestock 25 species of plants have been studied. The experimental work on horses, cattle, and sheep has been carried on almost entirely at the experiment station on the Fishlake-Fillmore National Forest, near Salina, Utah, while the work on the smaller animals, like guinea pigs, as well as most of the microscopic and chemical work, has been done in the laboratories in Washington.

The practical work on the death camas species (*Zygadenus*) has been completed. Work on the corn cockle (*Agrostemma githago*) and the cocklebur (*Xanthium echinatum*) is nearing completion. In feeding experiments with the rayless goldenrod (*Isocoma wrightii*) on cattle and sheep it has been definitely proved that the toxic principle is excreted in the milk and can poison the young. In chemical studies of white snakeroot (*Eupatorium urticæfolium*) the toxin has been located in the fatty fraction, and it has been demonstrated that acetone is excreted by the lungs and kidneys of cattle and sheep poisoned by this plant. The poisonous character of the common greasewood (*Sarcobatus vermiculatus*) has been verified by feeding experiments, and chemical work has shown that the toxic agent is of a mineral character. Among other plants studied are several species of the lupines and two loco plants.

### BRANCH LABORATORIES.

The work of the branch pathological laboratory at Chicago consisted largely of investigations relative to meat inspection. The softening of hams by the presence of sarcosporidia was studied. Investigations to determine whether it is possible to detect the presence of sarcosporidia in hams before boiling indicated that it is quite difficult to do this by ordinary examination. In the study of cutaneous tuberculosis in cattle it appeared that guinea pigs injected with material from skin lesions of tuberculosis do not contract that disease as early as when injected with tuberculous lesions from other parts of the body. Further observations were made in connection with so-called hyperplasia of the bone marrow in cattle.

At the Omaha branch laboratory 924 specimens were received for examination and diagnosis, including 753 specimens from cattle that had reacted to the tuberculin test, of which 226 were found to contain tubercle bacilli. Of the positive cases of tuberculosis 24 were taken from growths in the subcutaneous tissues. The remaining specimens represented a wide variety of diseases and conditions.

At the Denver branch laboratory 584 specimens were received for examination and diagnosis. The samples represented tissues from horses, cattle, sheep, goats, swine, poultry, and dogs, as well as samples of milk, water, and stock feed. The diseases encountered were tuberculosis, hemorrhagic septicemia, abortion, necrobacillosis, blackleg, lumpy jaw, anthrax, garget, and carcinoma in cattle; hog cholera, septic infection, septicemia, coccidiosis, tuberculosis, and necrobacillosis of swine; icterohematuria and hemorrhagic septicemia of sheep; diet deficiency, white diarrhea, cholera, pox, coccidiosis, and botulism of poultry; and septic infection, swamp fever, forage poisoning, hemorrhagic septicemia, and carcinomatosis of horses.

### BIOCHEMIC DIVISION.

The work of the Biochemic Division, under Dr. M. Dorset, chief, has continued to consist chiefly of investigations concerning hog cholera, studies of dips, disinfectants, and insecticides, laboratory research relative to meat products, and the preparation of tuberculin and mallein.

### HOG-CHOLERA INVESTIGATIONS.

As indicated in previous reports, one of the important lines of investigation regarding hog cholera has been the study of cases where losses have occurred among hogs after immunization by the simultaneous method. A State experiment station worker reported that anti-hog-cholera serum and hog-cholera virus contained *Bacillus botulinus*, from which it was inferred that many of the so-called "breaks" in hog-cholera immunity were caused by the presence of this organism or its toxin in commercial serum and virus. During the year this division made a study of the subject. A large number of samples of commercial anti-hog-cholera serum and of hog-cholera virus, including a number reported to be contaminated, were carefully examined. In no case was it possible to demonstrate the presence of either *Bacillus botulinus* or its toxin. Some experimental work was also done to test the growth and effects of this organism and its spores in this connection. The studies and experiments led to the conclusion that *Bacillus botulinus* is not an important factor in causing "breaks" following the use of anti-hog-cholera serum.

The relation of *Bacillus suipestifer* to breaks following simultaneous immunization has also been the subject of study and experiment. Bacteriological examination of a large number of samples of commercial hog-cholera virus failed to reveal the presence of this organism in any case. It appears that there is no need to fear bad results from its presence in properly prepared virus. The results of experiments do not prove that *Bacillus suipestifer* is the cause of any large proportion of breaks, but they do indicate that a severe *suipestifer* infection occurring simultaneously with the administration of the simultaneous treatment may be a cause of trouble. It was found also that ill effects resulting from the administration of this organism at the time of simultaneous inoculation could be in a large part overcome by the administration of increased doses of anti-hog-cholera serum.

In pursuing further the studies of the cause of breaks following immunization, a number of samples of commercial serum and virus have been studied. The serum in most cases was part of a batch which was believed to be contaminated or lacking in potency as shown by unsatisfactory field results. In no case was such serum found to be contaminated in such a way as to make it injurious to hogs, and only in exceptionally rare instances was it found to be of low potency. Among six samples of commercial virus, purchased at random on the market, one was found to be so entirely lacking in potency that it did not produce disease when injected alone into susceptible pigs, and it also failed to produce a lasting immunity when injected simultaneously with serum. These tests of virus suggest that when properly prepared and preserved there need be little fear of injury due to infection other than hog cholera when commercial virus is used. They also suggest that some of the so-called late breaks in immunity that have occurred in herds treated simultaneously several months earlier may occasionally be due to the lack of potency in the virus at the time of use.

Previous tests showed that one five-thousandth of a cubic centimeter of blood from a pig suffering from hog cholera was sufficient to induce disease in a susceptible pig when administered subcutaneously. Further studies of this question of the minimum lethal dose of hog-cholera virus have shown that the disease may be produced by as little as one twenty-five-thousandth of a cubic centimeter. Further studies along this line are being carried out.

Occasion was had to test again the potency of clear anti-hog-cholera serum prepared in 1917. The serum, 4 years old, was found apparently to be as potent as when it was prepared.

Virus was furnished to a number of commercial plants upon request, to enable them to renew strains of virus which they were employing in the production of hog-cholera serum.

A study of the period of incubation of hog cholera was made primarily with the object of obtaining data which might be helpful to serum producers in selecting virus used in the production of anti-hog-cholera serum and in selecting virus used with the serum for simultaneous immunization. The results showed that following the subcutaneous injection of blood from a pig sick of hog cholera about 50 per cent of the susceptible pigs showed visible symptoms of disease on the fourth day; that by the end of the fifth day more than 81 per cent showed symptoms of disease, and by the end of the sixth day more than 98 per cent exhibited visible symptoms. These observations led to the conclusion that hog-cholera virus which will produce visible symptoms and a rise in temperature in 50 per cent or more of susceptible pigs on the fourth day after subcutaneous injection, and which has the power to cause progressive disease so that a considerable majority of the injected pigs are "off feed" on the fifth day, will produce a good serum, will be adequate for making serum tests, and will result in a lasting immunity when properly administered with anti-hog-cholera serum.

A study of various strains of *Bacillus suipestifer* isolated at different times from different sources has developed the interesting fact that there appear to be two groups of this microorganism. One of these produced blackening of lead acetate agar while the other did not produce blackening. These characteristics seem to be fixed. A preliminary study of the agglutination reactions led to the belief that the two strains are not serologically identical. A paper reporting this and further work and its application with regard to culture media has been submitted for publication.

The chemical studies of anti-hog-cholera serum and the effect of preservatives on the proteins of hog-blood serum have been continued. Two new methods for the determination of globulins in serums have been worked out and published during the year. Further study is being given to the chloroform-hemoglobin reaction, which is used as described in the last annual report for the concentration and refining of old defibrinated blood serum. A study of the effect of formaldehyde on serum proteins has been nearly completed. It has been noted that there are certain differences in hogs' blood with respect to the reaction to formaldehyde. Some of the blood serum gelatinized in the presence of suitable amounts of formaldehyde, whereas other serums did not undergo this change under the same conditions.

Study is being given to this reaction to determine whether or not any sharp difference exists between the blood of healthy hogs and that of hogs affected with cholera.

### SO-CALLED "HOG FLU."

Considerable study was given to the disease commonly known as "hog flu." Twelve herds were carefully observed and the conclusion was reached that this illness is not related to hog cholera in any way, and that from the standpoint of symptoms at least it is different from any disease of hogs which prevailed in the United States prior to 1918. This condition appears to be growing more prevalent. It appears chiefly in the fall, winter, and early spring. The losses from death as a rule are not large, but the loss in condition among affected hogs is very marked. A number of different bacteria have been isolated from hogs affected with the disease, but so far no single organism has been shown to be capable of producing it. Tests thus far made indicate that the disease itself is of low contagiousness and that it is transmitted from sick to healthy pigs only with difficulty. It is planned to make an intensive study of this condition if it appears again during the approaching fall and winter.

### RESEARCH WORK ON MEATS AND MEAT FOOD PRODUCTS.

Excellent progress was made in the study of the composition, nutritive value, and wholesomeness of edible viscera from meat food animals. The study of the proximate chemical composition of the edible viscera has been completed and the results are being prepared for publication. In the determination of the content of vitamin B, or the antineuritic value, of the same tissue and of voluntary muscle as well, hog muscle was found to be relatively rich in this vitamin and to compare very favorably in this respect with certain glandular organs recognized as being well supplied with it, namely, the kidney and the liver. Beef and veal were found to have much lower content of vitamins, and lamb occupied an intermediate position. The heart, liver, and kidney, respectively, from each of the three classes of animals each had a relatively high vitamin content; the spleen, thymus, pancreas, and brain had much lower values, while the blood, lungs, and tripe contained very little of the vitamin. On the whole, the edible viscera of the hog appeared to be rather richer in vitamin B than the same tissue from other animals.

The study of the nutritive value of the protein of the various animal tissues has been continued. These tests are being carried on with white rats, which are fed rations containing the dried tissue to be tested as the sole source of protein. At least 12 rats are required to test the value of the protein from a single tissue, and the test covers a period of 90 days, so that this line of investigation is very time consuming. The determination of the nutritive value of the protein from the following tissues has been nearly or quite completed: Ox, hog, and lamb liver; ox, hog, and lamb heart; ox and hog kidney; ox, hog, and lamb muscle. Experiments are in progress with ox and hog spleen and tripe, hog stomach, ox lungs, and miscellaneous tissues.

The study of the emaciation in cattle has yielded results of considerable interest. The chemical composition of the flesh from a considerable number of carcasses of cattle condemned for emaciation was found to differ very markedly from that of normal lean beef. The results at hand are a clear indication of an advanced stage of inanition, during which the muscles have suffered marked changes in composition. Feeding tests to determine the nutritive value of the protein from the flesh of emaciated cattle are in progress and a certain amount of chemical work remains to be done.

An investigation of the rancidity of fats, intended to determine more precisely than is now known the nature of the chemical changes which take place in fats during the process of becoming rancid, and also, if possible, to determine the physiological effect of compounds that may be identical in rancid fats, is under way. Considerable progress has been made but it is too early to announce results.

## DIPS AND DISINFECTANTS.

The laboratory of dips and disinfectants received and examined 112 samples of dips, disinfectants, and related materials.

During the calendar year 1921 there were sent out to inspectors in the field 1,009 new test outfits for arsenical dips and supplies sufficient to make 471,840 field tests for arsenic; 67 new test outfits for lime-sulphur dips and sufficient supplies to make 16,000 tests; and 21 new outfits for testing nicotin dips and supplies sufficient to make 5,580 tests. There were thus sent out a total of 1,097 new test outfits and supplies to make a total of 493,420 field tests.

Work has been continued on the general subject of the mode of action of phenolic disinfectants, with special attention to the fundamental question of why the phenols differ so markedly in germicidal activity. After obtaining with some difficulty a sufficient number of pure phenols, and then making an exhaustive comparative study of their physical and chemical properties and correlating the observed differences with the differences in their germicidal activities reported by bacteriologists, the conclusion was reached that the differences in killing power manifested by different phenols are apparently due to physical differences and are not directly a consequence of any difference in chemical action.

The phenol investigations have led to a study of colloidal phenomena and principles. It is believed that new relationships have been discovered and certain important principles formulated which will be of great assistance in correlating and explaining the generally obscure phenomena of suspensions, emulsions, and colloids.

## TUBERCULIN AND MALLEIN.

The demand for subcutaneous tuberculin has continued to decrease, while there has been a marked increase in the requests for ophthalmic and intradermic tuberculin. The year's output, which was supplied mostly to bureau inspectors but partly also to State and local officials, was as follows: Subcutaneous tuberculin, 2,477,224 cubic centimeters, a decline of 42 per cent from the preceding year; ophthalmic tuberculin, 1,577,880 disks, an increase of more than 190 per cent; intradermic tuberculin, 1,026,745 cubic centimeters, sufficient to make 5,133,725 tests. The newly installed apparatus for producing ophthalmic disks has worked satisfactorily and has enabled the laboratories to produce disks in the large numbers shown.

The quantity of mallein supplied to bureau and to State officials was 7,271 cubic centimeters.

### COOPERATION WITH INSECTICIDE AND FUNGICIDE BOARD.

One hundred and fourteen samples of insecticides intended for use on domestic animals were examined for the Insecticide and Fungicide Board, 9 of which were found to be misbranded and adulterated and 72 misbranded.

## ZOOLOGICAL DIVISION.

The investigation of parasitic diseases of animals and the study, collection, and determination of animal parasites have been continued in the Zoological Division under Dr. B. H. Ransom, chief.

### ROUNDWORMS OF SHEEP.

At the bureau farm near Vienna, Va., a test of a method of controlling stomach-worm infestation by the administration of 1 per cent copper-sulphate solution at intervals of three weeks throughout the year has given very satisfactory results. There has been no evidence of injurious effects upon the sheep, and the number of worms has been diminished almost to the point of disappearance. The destruction of the worms in the older sheep has correspondingly reduced the infestation of the ground and has thus protected the lambs from picking up the parasites in numbers sufficient to cause any damage up to the time of weaning. Before weaning it has not been found necessary to dose the lambs, although the fact that they have acquired a few worms, as shown by the presence of eggs in their feces, shows that to retain control over the parasites it will be necessary to dose them with copper-sulphate solution throughout the summer. The dose of the 1 per cent solution of copper sulphate is 4 fluid ounces for a lamb of 80 pounds or for larger sheep. Lambs of 60 pounds are given 3 ounces, and 70-pound lambs are given 3½ ounces. The dosing of the ewes at three-week intervals is interrupted two weeks before lambing, but is resumed soon afterwards. This method of stomach-worm control—repeated dosing of the entire flock throughout the year—has thus far proved the most satisfactory of any tried. It appears troublesome, but as a matter of fact is easily carried out. As many as 50 sheep can be dosed in an hour, and no preliminary fasting of the animals is necessary. It has been found that the method not only keeps stomach worms well under control but reduces the prevalence of nodular worms, various small intestinal nematodes, and tapeworms.

### ROUNDWORMS OF HOGS.

Investigations have been continued in McLean County, Ill., on the practical control of Ascaris infestation. Observations were made on nearly 10,000 pigs reared on 31 farms in the autumn of 1921 and spring of 1922, following the method of control which has been under test during the past three years. This method consists in observing special precautions to prevent the infection of young pigs until they are at least 4 months of age, after which they are less likely to become infected and less likely to suffer seriously if they do become infected. As in former years, this method has proved highly satisfactory in preventing losses among pigs not only from worms but from other diseases which under ordinary conditions destroy a large percentage of the pig crop on many farms in the Corn Belt. The method is rapidly coming into use not only in McLean County but in other localities, where the losses among pigs in recent years, notwithstanding the effective control of hog cholera, have often been so heavy that many farmers have seriously considered abandoning the raising of hogs. A great popular interest in this method is shown by the fact that in a recent tour of the experimental farms in McLean County, conducted by the local farm bureau, between 200 and 300 persons participated, including farmers not only from McLean County but from seven other counties of Illinois.

In experiments on the effects of roundworm infestation on the growth of pigs, animals that were given a single dose of roundworm eggs were not apparently affected, so far as growth was concerned, except during the stage of lung invasion and several weeks afterwards. At the end of two months they had made normal gains. Pigs subjected to repeated infections, however, were seriously affected and at the age of 4 months weighed only about half as much as other pigs of the same age and breed, kept on the same feed but protected from worm infection. From another experiment evidence was obtained which indicates that the invasion of the lungs by Ascaris larvæ is a predisposing factor in lung infections with bacteria, but further work on this subject is necessary before definite conclusions can be drawn.

Ascaris eggs buried in the ground in Chicago, Ill., in October were found still alive nine months later, confirming other experiments relating to the longevity of the eggs.

### TREATMENT AND CONTROL OF EXTERNAL PARASITES.

Ox warbles.—Experiments in the prevention of warble infestation were continued on farm cattle in the Corn Belt States and on range cattle in the Southwest. Wading tanks with used automobile oil or fuel oil poured on the surface of the water were used as a means of applying treatment to the feet and lower parts of the legs of cattle, which were required to pass through the tanks. Farm and dairy cattle soon learned to pass voluntarily through the tanks, but range cattle often avoided them. It was found, however, that range cattle would readily pass through shallow depressions in the ground, containing water with oil on the surface. These depressions made in gateways or openings leading to watering places were used as wading tanks. Gravel placed in the depressions from time to time rendered the bottom hard and practically impervious. Although the oil on the water in the tanks had a tendency to collect at one side during windy weather, some oil usually remained near the borders on all sides and animals passing through carried out more or less of the oil on their feet and legs. The use of the tanks was found to reduce infestation greatly but did not entirely prevent it.

SARCOPTIC MANGE OF HORSES.—After four treatments with 10 per cent solution of sodium hyposulphite the infected skin in cases of horse mange showed decided improvement, and after seven treatments the skin was apparently normal. The interval between treatments was six days. In some cases a 10 per cent solution of acetic acid was applied immediately following the application of the hyposulphite solution. This method of treatment was not permanently successful, as symptoms of mange again appeared two months after the last treatment. Repeated applications of a 25 per cent solution of sodium hyposulphite followed by a 10 per cent solution of acetic acid proved efficacious in curing mild cases of horse mange, but failed in advanced cases.

EXTERNAL PARASITES OF HOGS.—Pine oil and 2 per cent emulsion of pine tar proved less efficacious than crude petroleum as remedies for lice and mange of hogs.

SHEEP SCAB.—In experiments on the protective action of various dips against reinfection with sheep scab, lime-sulphur dip and nicotin dip afforded protection for a period of 33 days after dipping. Nicotin dip with 2 per cent flowers of sulphur added afforded protection for 69 days.

### MISCELLANEOUS INVESTIGATIONS ON ANIMAL PARASITES.

Investigations in regard to the anthelmintic value of carbon tetrachlorid have been carried on by tests against various worms in chickens, dogs, swine, sheep, and cattle, and toxicity tests of this drug have been made on these animals and on turkeys and rabbits. The results confirm the conclusions drawn from previous experiments on dogs, horses, and monkeys to the effect that carbon tetrachlorid is especially effective in removing bloodsucking nematodes and is also effective in removing ascarids and some other nematodes.

The drug has a large margin of safety between the effective therapeutic dose for removing certain worms and the lethal dose, in the case of chickens and dogs. It is well tolerated by turkeys, rabbits, swine, and monkeys, and apparently by horses. Ruminants appear to be less tolerant of this drug than birds, rabbits, carnivores, swine, and primates, but doses which remove all the stomach worms present are tolerated without evidence of real injury and the efficacy of the drug in removing stomach worms, other trichostrongyles, hookworms, and nodular worms from ruminants warrants further study along this line to ascertain a safe and effective dosage.

Following the work in this division in which the value of this drug in removing hookworms from dogs was first ascertained, carbon tetrachlorid was brought to the attention of the medical profession as a drug worth testing in human medicine for removing hookworms. Reports up to the present time of tests along this line by physicians in the service of the International Health Board of the Rockefeller Foundation have been very favorable. The drug has been administered to more than 50,000 human hookworm patients and has so far proved safer, more effective, less unpleasant in its effects on the patient, and cheaper than the other drugs used for the removal of hookworms. Carbon tetrachlorid is now established in veterinary medicine as the best drug for the removal of hookworms from dogs and foxes and is being extensively used for this purpose and for the removal of ascarids from these animals, as it appears to be much safer for these animals and only slightly less effective in removing ascarids than is oil of chenopodium. It promises to become established as the best drug for the removal of the human hookworms. The experiments carried on during the past year indicate that it will find further uses against other worm parasites in man and several of the domesticated animals. A few experiments with a mixture of carbon tetrachlorid and castor oil failed to show that this remedy is efficacious in removing thorn-headed worms from swine.

Studies of treatment for demodectic mange in dogs, in cooperation with the Insecticide and Fungicide Board, have been continued with a view to ascertaining some dependable treatment for this refractory disease.

A new species of gullet worm, *Gongylonema ransomi*, occurring in the tongues and gullets of swine has been described and provisions are now in effect in the Federal meat-inspection service for removing these worms from hog tongues. A study of the regional distribution of this parasite in this country indicates that in certain areas swine show a high degree of infestation while in other areas swine appear to be free from infestation.

Additional work has been carried on in regard to strongyles of horses and the adult tapeworms of sheep and cattle.

Confirming the work of other investigators, experiments in infecting chickens with *Ascaridia perspicillum* have failed to show that the larvæ of this parasite pass through the lungs before settling down in the intestine to develop to maturity.

During the year 1,129 fecal samples from imported sheep dogs were examined for parasites that might be injurious to livestock. Of these, 126 were found infested with tapeworms of the genus Tænia and were subjected to anthelmintic treatment before release from quarantine.

Publications issued during the year include studies on the prevention of intestinal worms in pigs and on pig parasites and thumps. Papers were published outside of the department dealing with ascarids in swine, migration of larval ascarids in the body of the host, danger to children from playing in hog lots, unusual parasites of swine, notes on hookworms, a Syngamus from a calf, the guinea pig as a host of *Arduenna strongylina* and of *Hymenolepis nana*, the possible effect of heat on stomach-worm larvæ, the occurrence of the swine kidney worm in cattle, animal parasites of foxes, lungworms of domestic animals, relative value of treatment and prophylaxis in parasitic diseases, treatments for gastrointestinal parasites of horses, carbon tetrachlorid for removing hookworms, occurrence of *Dipylidium sexcoronatum* in the cat, a tapeworm from a whale, parasites of an African wolf, *Hymenolepis farciminosa* in the United States, horse strongyles, bots, gid, animal experimentation, and miscellaneous notes on nematodes.

The Index-Catalogue of Medical and Veterinary Zoology has been continued and preparation made for publishing additional parts of this highly valuable work.

## DIVISION OF VIRUS-SERUM CONTROL.

The supervision of veterinary viruses, serums, toxins, etc., under the law of 1913 has been continued by the Division of Virus-Serum Control under Dr. D. I. Skidmore, chief. This work consists of the issuance of licenses to establishments manufacturing veterinary biological products for sale in interstate commerce, the inspection of these establishments as to sanitary conditions and methods of production, the supervision of production, the testing of products, and the issuance of permits for the importation of such products from abroad. The object of this supervision is to assure the potency and harmlessness of this class of remedies.

At the beginning of the year there were 90 licensed establishments. Operations were discontinued in 4 of these, and 5 new establishments were licensed, so that at the end of the year there were 91 establishments operating under bureau licenses. During the year 19 licenses were terminated without prejudice to the establishments involved. In most instances licenses were reissued in the place of those terminated. On June 30, 1922, there were 59 licensed establishments producing only anti-hog-cholera serum and hog-cholera virus, 25 producing other biologics only, and 7 producing both classes of products. Seventy-five distinct classes of products were prepared. To supervise these establishments and products the bureau maintained 18 field stations with 39 substations in 22 States. Two permits were issued to as many firms importing veterinary biological products.

The production of anti-hog-cholera serum amounted to 665,790,925 cubic centimeters, of which 66,089,704 cubic centimeters consisted of clarified serum. There was destroyed as unfit for use 3,975,281 cubic centimeters of hyperimmune blood or serum in uncompleted form and 10,162,991 cubic centimeters of serum in completed form. The quantity of simultaneous virus produced was 33,317,533 cubic centimeters. The quantity of simultaneous virus destroyed before completion or at the time of collection was 340,815 cubic centimeters, while 976,125 cubic centimeters were destroyed after being completed for marketing. The production of hyperimmunizing virus was 159,875,507 cubic centimeters, of which there were destroyed 7,967,690 cubic centimeters at the time of collection and 472,258 cubic centimeters after preparation. To determine the potency and purity of the serum and the purity of the virus 9,528 tests of the former and 1,905 of the latter were made.

There were inspected and admitted to the premises of licensed establishments for use in the production and testing of serum and virus 405,770 hogs and 3,654 calves, while 518 hogs and 2 calves were rejected. In subsequent operations 26,212 additional hogs were rejected.

During the year 356 subcultures including 926 strains of organisms used in the production of licensed products were collected and subjected to laboratory examination, and 630 strains were found satisfactory and 296 unsatisfactory. Two hundred and sixty-five samples of products were also collected and examined, of which 218 were found to be satisfactory and 41 unsatisfactory.

The division has cooperated with the Bureau of Chemistry in an effort to prevent the sale of worthless remedies for hog cholera and other swine diseases. Recommendations were made leading to a considerable number of seizures of such so-called "cures."

## EXPERIMENT STATION.

The character of the work of the Experiment Station at Bethesda, Md., under Dr. E. C. Schroeder, superintendent, was similar to that of previous years, and comprised independent investigations of infectious diseases of domestic animals, investigations in cooperation with other scientific divisions of the bureau, and the provision of facilities for the other divisions to make investigations under normal farm and field conditions.

### BOVINE INFECTIOUS ABORTION.

Infectious abortion disease of cattle remained the subject of major importance. The knowledge now available on the etiology of this widespread and common evil seems adequate to serve as the basis for control measures. Such measures have been formulated, and as their practicability and efficiency should be tested on a larger scale than is feasible with the small number of cattle at the station, the use of two large, privately owned and maintained herds, one a beef and the other a dairy herd, has been obtained for the purpose, without other cost to the Government than the expenses incident to periodic inspections, the making of biological tests, and the necessary technical laboratory work.

It has been known for some time that the Bang abortion bacillus may attack swine as well as cattle. During the year a number of cultures of the bacillus obtained from outbreaks of abortion among swine were studied and compared with cultures isolated from outbreaks of abortion among cattle. The cultures from the two sources are identical in some respects but different in others. Attempts to infect swine with cultures from cattle have invariably failed, while similar attempts with cultures from swine have been successful and have caused actual abortions. The swine cultures are also more pathogenic for guinea pigs than the bovine cultures.

An investigation of commercial suspensions of abortion bacilli showed that these preparations are often not what they are labeled to be and that their use should be discountenanced. Further investigations on the subject are now in progress. For the time being it should be generally recognized that protective inoculation against bovine infectious abortion has not passed the experimental stage.

Investigations are now being made to determine whether the exposure of infected herds of cattle, in which abortions have ceased to occur, to strains of abortion bacilli from other herds may lead to a recrudescence of abortions. While it is too early to draw conclusions from this work, the indications are that the exposure of such an infected herd to abortion bacilli derived from outbreaks of abortion among swine may have serious consequences.

### TUBERCULOSIS.

Investigations on tuberculosis have been continued. More work has been done to perfect the method now in use to measure the purity and potency of tuberculin sold under Government license for veterinary uses and to throw light on the nature of the tuberculin reaction. Likewise investigations are being conducted regarding the time that elapses between the infection of cattle with tubercle bacilli and the development of tuberculin sensitiveness and on the causes on which variations in tuberculin sensitiveness depend.

Tests regarding the purity and potency of commercial tuberculin made it necessary in several instances to recommend the withdrawal of some of this material from the market. The frequency with which commercial tuberculin has been found to contain excessive numbers of dead tubercle bacilli has greatly declined, which is a desirable improvement, as it has been definitely proved that animals may be sensitized to tuberculin through injections of dead tubercle bacilli.

Some studies have been made on the type of the tubercle bacillus in unusual and atypical tuberculous lesions in cattle. In all cases the bacilli proved to be of the true bovine type.

During the year a large number of samples of butter and of cream cheese purchased on the open market were tested for tubercle bacilli. The butter of only one company was found to be infected, and this company has promised to take the necessary steps to insure the freedom of its product from contamination in the future. Likewise the cream cheese of only one company was found to be contaminated, a company from which samples had not previously been tested, and this company also promised to correct the evil and to make its product safe. On the whole the tests with samples of market butter and cheese are gratifying, as may be judged from the following comparison: Less than 10 years ago it was found that something more than 14 per cent of 122 samples of cream cheese purchased on the open market were contaminated with living, virulent bovine tubercle bacilli. Last year the examination of several hundred samples failed to show a single contamination, and this year the examination of several hundred samples revealed only a fraction of 1 per cent to be contaminated. Tests regarding the possible occurrence of tubercle bacilli in dairy products will be continued.

### MISCELLANEOUS WORK.

Various studies are in progress concerning the influence of diet on the rapidity with which tuberculous lesions develop in the bodies of infected animals; the influence of diet on the permeability of the mucous membranes for tubercle bacilli and other pathogenic microorganisms; the changes which occur in tuberculin when it is incubated with various animal tissues and organs; the influence of the vitamin content of the diet on susceptibility to diseases, etc.

A large number of small experiment animals were raised at a cost much lower than current market prices. Various tests were made with pathological material suspected to contain the virus of infectious diseases. Biological products of different kinds were supplied to the other laboratories of the bureau. Every available portion of the station's land was kept under intense cultivation to obtain forage for experiment animals.

# REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

United States Department of Agriculture,
Bureau of Plant Industry,
*Washington, D. C., October 12, 1922.*

Sir: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1922.

Respectfully,

Wm. A. Taylor,
*Chief of Bureau.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

## WORK AND ORGANIZATION OF THE BUREAU.

The Bureau of Plant Industry deals with all problems of plant production. These activities include the improvement of useful plants by selection and breeding, the investigation of destructive plant diseases and development of methods for their control, the introduction of new plants from foreign countries, the improvement in cultural methods for producing crops, and the development of improved methods of crop handling and utilization.

The bureau maintains field stations and conducts experimental work in all sections of the United States, including the irrigated lands on Government reclamation projects, and in cooperation with State agricultural experiment stations determines the occurrence and severity of plant-disease epidemics. A seed and plant exchange service is conducted between experts of foreign countries and American experts. The bureau supervises the purchase and mailing for the congressional distribution of vegetable, flower, cotton, tobacco, and lawn-grass seeds and of bulbs.

The scientific work of the bureau during the year has been carried on with the following organization:

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|---|---|
| Laboratory of plant pathology | Erwin F. Smith, pathologist in charge. |
| Pathological collections | Flora W. Patterson, mycologist in charge. |
| Plant-disease survey | George R. Lyman, pathologist in charge. |
| Fruit-disease investigations | M. B. Waite, pathologist in charge. |
| Citrus-canker eradication | Directed by K. F. Kellerman, associate chief of bureau. |
| Investigations in forest pathology | Haven Metcalf, pathologist in charge. |

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|---|---|
| Blister-rust control | S. B. Detwiler, forest pathologist in charge. |
| Cotton, truck, and forage crop disease investigations | W. A. Orton, pathologist in charge. |
| Crop physiology and breeding investigations | W. T. Swingle, physiologist in charge. |
| Soil-bacteriology investigations | Directed by K. F. Kellerman, associate chief of bureau. |
| Soil-fertility investigations | Oswald Schreiner, biochemist in charge. |
| Crop acclimatization and adaptation investigations | O. F. Cook, bionomist in charge. |
| Fiber-plant investigations | L. H. Dewey, botanist in charge. |
| Drug, poisonous, and oil plant investigations | W. W. Stockberger, physiologist in charge. |
| Plant physiological and fermentation investigations | H. L. Shantz, physiologist in charge. |
| Agricultural technology | N. A. Cobb, technologist in charge. |
| Seed-testing laboratories; enforcement of seed-importation act | E. Brown, botanist in charge. |
| Cereal investigations | C. R. Ball, cerealist in charge. |
| Tobacco and plant-nutrition investigations | W. W. Garner, physiologist in charge. |
| Alkali and drought resistant plant investigations | T. H. Kearney, physiologist in charge. |
| Sugar-plant investigations | C. O. Townsend, pathologist in charge. |
| Economic and systematic botany | Frederick V. Coville, botanist in charge. |
| Dry-land agriculture | E. C. Chilcott, agriculturist in charge. |
| Western irrigation agriculture | C. S. Scofield, agriculturist in charge. |
| Horticultural and pomological investigations | L. C. Corbett, horticulturist in charge. |
| Gardens and grounds | E. M. Byrnes, assistant in charge. |
| Demonstrations on reclamation projects | A. C. Cooley, agriculturist in charge. |
| Arlington Experiment Farm | E. C. Butterfield, assistant horticulturist in charge. |
| Foreign seed and plant introduction | David Fairchild, agricultural explorer in charge. |
| Forage-crop investigations | C. V. Piper, agrostologist in charge. |
| Congressional seed distribution | R. A. Oakley, agronomist in charge. |
| Biophysical investigations | G. N. Collins, botanist in charge. |

From September 1, 1921, to August 31, 1922, the changes in the personnel of the bureau were as follows: Resignations, 347; deaths, 9; transfers from bureau, 10; furloughs, 5; retirements, 1; terminations of appointments, 427. In the same period 1,143 appointments were made, a net increase of 344. On September 1, 1922, the numerical strength of the bureau was as follows: In Washington, 672; outside of Washington, 1,318; total, 1,990. The total number of employees in the bureau on the same date a year ago was 1,851.

The new publications of the bureau (Department Bulletins, Farmers' Bulletins, circulars, and miscellaneous documents, with contributions to the Yearbook and to the Journal of Agricultural Research) number 127, containing 3,114 pages, 280 full-page plates, and 627 text figures, issued in first editions aggregating 1,165,650 copies. The number of publications issued during the preceding fiscal year was 139, containing 3,223 pages, 238 full-page plates, and 793 text figures, the first editions aggregating 1,738,100 copies. The contributions of this bureau to the series of Farmers' Bulletins numbered 37 in 1918, 29 in 1919, 14 in 1920, 37 in 1921, and 17 in the fiscal year covered by this report. As usual, a considerable number of Farmers' Bulletins emanating from this bureau were revised more or less extensively, while many others were reprinted without revision of importance but with new covers or title-pages. The number of contributions from this bureau to the Journal of Agricultural Research was 29, or 11 less than during the preceding fiscal year, the reduced number being caused by the suspension of the journal, beginning December 1, 1921. These publications show in considerable detail some of the activities of the bureau.

The following statement outlines the work of the bureau not otherwise recorded, summarizing the status of the most significant accomplishments during the past fiscal year.

## FIELD CROPS.

### WHEAT.

*Extension of improved varieties.*—Two new wheats developed in the breeding experiments in cooperation with the agricultural experiment station of Cornell University have been named Forward and Honor. These now are being grown commercially, and seed is offered for sale by seedsmen and farmers in New York State. A mass selection of the Purplestraw variety developed at the Arlington Experiment Farm is being widely grown in eastern North Carolina and is giving good results.

Kota, a bearded, hard red spring variety, discovered in 1918 to be especially resistant to stem rust, was grown in 1921 at 30 experiment stations to determine its value in comparison with adapted commercial varieties of both common and durum wheats. During the past three years its resistance to stem rust has proved nearly equal to that of the most resistant durum varieties. The commercial stocks of Kota seed were increased to about 6,000 bushels in 1921, and nearly all of this was sown in 1922.

Red Bobs, an early variety of hard red spring wheat developed in Saskatchewan, Canada, was first included in varietal comparisons in this country in 1920. In both years it has outyielded all other varieties of hard red spring wheat at the Fergus County substation, Moccasin, Mont., and has produced excellent yields at other points in Montana and Wyoming. Eastward in the Dakotas and Minnesota, however, it is susceptible to injury by stem rust.

Karmont is the name which has been given to a high-yielding pure-line selection of Kharkof hard red winter wheat developed cooperatively in Montana. In appearance this variety is identical with Kharkof, but it has significantly outyielded it in experiments in Montana. The seed was increased in 1921, and a small commercial distribution was made in Montana.

Hard Federation and Federation, two varieties of white wheat introduced from Australia by this department, continue to give good yields in the Pacific coast area. Hard Federation is unusually well adapted to the dry lands of Oregon and California, where it outyields such improved commercial varieties as Early Baart and Pacific Bluestem. Federation has given high yields under irrigation in eastern Oregon and southern Idaho in the last three or four years. At the substation at Aberdeen, Idaho, it has outyielded the high-yielding Dicklow variety by more than 5 bushels per acre in the last three years and has exceeded that variety in milling and baking quality. During 1921 the commercial supply of seed of Hard Federation was increased to more than 6,000 bushels and that of Federation to more than 1,000 bushels. White Federation, a related variety producing good yields in California, has been increased commercially in that State.

Durum wheats have continued to outyield common wheats, including Marquis, in the spring-wheat belt of the northern Great Plains and prairie areas. Some of the high-yielding rust-resistant durum varieties developed cooperatively by this department and the State agricultural experiment stations unfortunately do not produce a first-class quality of macaroni and other alimentary pastes. Preliminary experiments show, however, that Arnautka, Kubanka, Peliss, and Mindum make semolina products of satisfactory quality. The acreage of Kubanka has been rapidly increasing throughout the durum-growing sections, because it is more rust resistant than Arnautka. Peliss has been increased in Montana and Mindum in Minnesota.

*Barberry eradication for the control of black stem rust.*—The campaign for the eradication of the common barberry in order to control the black stem rust of wheat was begun in the spring of 1918 and is now in its fifth year. The eradication area comprises 13 of the north-central wheat-growing States, namely, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. All of these States now have enacted legislation requiring the removal of common barberry bushes. The campaign is conducted in cooperation with the State agricultural college in each of the States, with the State department of agriculture in most of them, and with the Conference for the Prevention of Grain Rust. Investigations of the time, rate, and manner of spread of rust from barberries, made during the summer, give additional evidence of the enormous losses directly traceable to individual bushes and hedges.

The farm-to-farm survey was continued during the past year, and an area equivalent to about 122 counties was completed. Of these, 24 counties in Minnesota were surveyed with funds furnished by that State. In this survey 141,251 bushes were located on 4,011 properties, of which 84,572 bushes were escapes from cultivation on 471 farms. A total of 159,561 bushes was removed from 4,574 properties. In addition to the farm-to-farm survey a resurvey was made of the cities and villages in each county covered. A resurvey to locate and destroy sprouts and seedlings on properties previously having barberries in the counties earlier covered in the farm-to-farm survey was carried forward. In this resurvey 33,811 sprouts were found and eradicated. Numerous seedlings and a number of bushes not removed by the property owners upon first notification were destroyed.

From the beginning of the campaign to June 30, 1922, almost all cities, towns, and villages in the 13 States included in the eradication area were surveyed. The original survey has been completed in Montana, Colorado, and Wyoming and a resurvey made for finding and eradicating sprouts and seedlings appearing since the original survey was completed. In the other 10 States the original survey has covered an area of approximately 330 counties. A resurvey of each property on which barberries have been found is being carried forward, and areas in the vicinity of large hedges or large bushes, either cultivated or escaped, which are old enough to bear seeds have been designated for a more careful resurvey.

During the entire campaign a total of 5,625,289 bushes has been located on 50,287 properties. Of these, 3,296,378 were escaped bushes on 2,440 properties. A total of 4,457,638 bushes has been removed from 46,366 properties. Of the 1,168,651 bushes remaining on 3,921 properties, the greater number are in a few large escaped areas in the States of Wisconsin, Illinois, and Michigan. These areas can not be cleared immediately because of their extent and the difficulty of eradication.

*Take-all and similar diseases of wheat.*—Diseases of the group to which take-all belongs have been found in Oregon, Washington, California, Arkansas, Kansas, Indiana, Illinois, Wisconsin, New York, and Virginia. Investigations of these diseases are in progress in cooperation with the experiment stations of most of these States.

It has been found that the true Australian take-all, caused by *Ophiobolus graminis*, occurs in New York, Virginia, Indiana, Arkansas, Oregon, and Washington. During the spring of 1922 this disease was found causing considerable losses in Kansas also. Field investigations have begun in Kansas, Oregon, and Washington, and laboratory investigations have been conducted at Madison, Wis. In Kansas there also occurs a foot-rot disease of wheat which is very similar to take-all, if not identical with it. As yet it is not certain that all of the foot-rot diseases in Kansas are true take-all, as the take-all fungus has been definitely identified on the diseased plants from only one farm.

The rosette disease of wheat, the cause of which is as yet not definitely known, has recurred in Illinois and Indiana, causing heavy losses in certain cases. Marked progress has been made in finding the relative susceptibility of an extensive series of wheat varieties. It has been found that a considerable number of leading varieties of wheat are resistant to or immune from this disease. Investigations to determine the cause of rosette are being pushed vigorously.

Investigations also have shown that the Helminthosporium disease of wheat is distinct from both rosette and true take-all. This disease occurs over practically the entire spring-wheat area and over part of the winter-wheat area. Durum wheat suffers most from this disease. No effective control measures have been found.

## OATS.

Among the improved varieties of oats, the four new pure-line varieties, viz. Cornellian, Comewell, Standwell, and Empire, developed in cooperation with the department of plant breeding at the Cornell University Agricultural Experiment Station and distributed to farmers in New York last year, have been very much in demand for growing in that State. Some progress is being made in eliminating the gray color of the Cornellian by crossing it on a high-yielding white oat.

The four new varieties, Albion (Iowa No. 103), Richland (Iowa No. 105), Iowar, and Iogren, developed in the cooperative experiments with the Iowa station, particularly Albion and Richland, the older selections, are grown more extensively each year in Iowa and adjoining Corn Belt States. At the International Hay and Grain Show in Chicago in 1921 three of these varieties—Albion (Iowa No. 103), Richland (Iowa No. 105), and Iowar—won 50 per cent of the premiums offered for oats in the region to which they are adapted. On the farms of 50 Iowa cooperators in 1921 the Iowar outyielded the home-grown variety by an average of 4.49 bushels. Among 10 cooperators outside of Iowa an average yield of 2.86 bushels in favor of this new variety was obtained, though 7 of these cooperators grew it in comparison with other selected strains.

Iogren, the most recent addition to this already notable list, has become a very popular oat in northern Iowa and southern Minnesota. Its value in this territory was shown in the unfavorable season of 1922. Because of its resistance to the rather severe rust epidemic which prevailed and to the generally unfavorable weather conditions, this oat apparently will make a record yield in 1922. It is a pure-line selection from the Green Russian variety. It was isolated in 1911 and has been included in the cooperative varietal experiments at the Iowa station since 1916. In these experiments it has made an average yield of 64.85 bushels per acre, as compared with a yield of 57.2 bushels from the Green Russian parent. A large distribution of seed of the Iogren oat was made in the spring of 1922, and it is believed that it will prove superior to any of the varieties previously distributed.

Idamine, a high-yielding pure-line selection from Silvermine, the well-known midseason white oat, which was developed at the Aberdeen (Idaho) substation and first distributed in 1921, has become popular, particularly for irrigated lands.

## CORN.

Investigations conducted in cooperation with the Indiana, Wisconsin, Kansas, and Illinois agricultural experiment stations and the Funk Bros. Seed Co., Bloomington, Ill., continue to show that the root, stalk, and ear rots of corn are of great importance in many States. In certain of the experimental plats during the past season the reductions in yield of marketable corn due to these diseases were found to be more than 30 per cent.

Closely related diseases of sweet corn and of field corn are concerned in this complex group of maladies. It has been found that the wheat-scab fungus (*Gibberella saubinetii*) is one of the important parasites concerned, as is also the dry-rot fungus (*Diplodia zeae*). The fungus *Fusarium moniliforme* also is commonly associated. These disease-producing fungi are seed borne and cause the blighting and dwarfing of seedlings, irregular stands, weakened and barren plants, and reduced yields. It has been found also that another group of maladies which manifest themselves by the purpling of stalks and leaves, browning of central fibrovascular bundles in the stalk, and barrenness is caused in part by one or more species of Cephalosporium. Previously, none of these fungi had been shown to be pathogenic on corn. Certain bacteria also are associated with these fungi, and their identity and respective rôles are now being investigated.

Control measures are being studied from various angles, both seed selection and soil management being involved. From the standpoint of the seed the most feasible control measures are: (1) Careful field selection of seed ears before killing frost; (2) proper curing and storage of such seed ears; (3) careful study of the physical characters of these ears and special germination tests, only the best ears being retained for seed purposes; (4) the development and use of resistant strains.

### BARLEY.

Investigations conducted in cooperation with the Wisconsin Agricultural Experiment Station have shown that the stripe disease of barley (*Helminthosporium gramineum*) may be perfectly controlled by developing a clean seed plat. Known seed treatments do not give perfect control and therefore have been supplemented by roguing. A small quantity of seed was first carefully treated and sown in a spot isolated from other barley. The developing crop was subsequently carefully watched for the appearance of scattered plants affected by the stripe disease. All such plants were promptly removed before spores of the fungus were formed. Careful roguing in this way has proved successful in eliminating barley stripe from one of the best strains of barley in Wisconsin. This clean seed is now being increased.

### FORAGE CROPS.

*Soy beans.*—The soy bean is rapidly approaching the point where it may be regarded as a staple crop. Its popularity is rapidly increasing in the Corn Belt, and it promises to become a valuable oil plant as well as forage crop. Several factories have been equipped or are being equipped with machinery for the manufacture of soy-bean oil and meal as well as for various food products, such as soy sauce, flour, and milk powder. Investigations with these beans have been extended considerably to meet the increasing demands for information relative to the culture, varieties, and utilization of the crop. About 175 introductions of soy beans were received from Manchuria, Japan, and China in 1922. Many of these appear to be of promise for central and northern conditions. Much progress is being made with soy beans in the South, where in past years the crop has not been very popular because of the shattering tendencies of the varieties that were grown. The Biloxi variety, however, on account of its nonshattering characteristics has done much to increase the popularity and acreage of the crop in the Gulf Coast States. This variety is also found to be resistant to nematodes and wilt. It has given most excellent results for forage and seed production.

*Velvet beans.*—Efforts are being continued to popularize this valuable forage and soil-improving crop in the South by developing new varieties. Through the crossing of early-maturing strains with the Bush variety some promising hybrids have been developed. Some of these are very prolific and will apparently make it possible to push the velvet-bean belt appreciably northward from its present limits.

*Mung beans.*—The mung bean is coming into prominence through its freedom from attack by the Mexican bean beetle. It is now being extensively advertised throughout the South for forage purposes. Tests have been conducted in various Southern States for the purpose of studying its resistance to the attack of the Mexican bean beetle and to get definite information on its yield of forage and seed as compared with other crops.

*Red clover.*—Tests have been continued to determine the value of imported red-clover seed. Field tests were carried on coöperatively with the agricultural experiment stations of Wisconsin, Michigan, Ohio, Pennsylvania, Tennessee, Idaho, and Oregon, as well as with individual farmers in these States and at the Arlington Experiment Farm. The results obtained confirm previous conclusions and establish beyond doubt the fact that red-clover seed imported from Italy is not reliably hardy north of the Ohio River. At Arlington it was also found that while the imported red clovers passed the winter without appreciable mortality, a large percentage of the plants died after the first cutting the following season, while plants from domestic-grown seed made a vigorous second growth.

*Silage.*—Preliminary feeding tests with a large number of silages were conducted last year at Beltsville, Md., and Redfield, S. Dak., in cooperation with the Bureau of Animal Industry. These tests are being continued this year, and the results indicate that herbaceous plants very generally make palatable silage if proper methods are used. The tests at Redfield, S. Dak., quite clearly establish the fact that the difficulty generally reported in connection with the making of legume silage, particularly from alfalfa and soy beans, is due largely to the fact that the cut material is not sufficiently compacted in the silo. Preliminary tests to determine how various substances added to freshly cut plant material when ensiled modify the character of the silage have been made. These investigations are being continued on a larger scale.

*Molasses grass.*—Though introduced from South America by the department some years ago, molasses grass, or gordura grass (*Melinis minutiflora*), has only recently commenced to receive the serious attention of stockmen in the southeastern United States. At the present time one firm which owns extensive pastures near the northern shore of Lake Okeechobee, Fla., is planting this forage crop on a large scale, having found it to be highly satisfactory in that region.

*Perennial teosinte.*—Considerable interest attaches to the discovery in southern Mexico of a perennial species of teosinte, the native Mexican grass which is the nearest relative of corn. Teosinte has been known previously only as an annual. It is recognized as a valuable forage plant, but its use has been restricted by its slow growth in the seedling stages and the difficulty of obtaining seed. These difficulties will be overcome if the perennial form proves adapted to conditions in the United States. Living plants and seeds of the perennial species were obtained in Jalisco by agents of the bureau and are now being propagated in southern California and in Washington, D. C.

*Poisonous plants in pastures and ranges.*—Plant surveys were made on the ranges of Arizona and New Mexico to determine the identity and distribution of poisonous species responsible for heavy losses of live stock in those States. Special attention was given to the loco problem, since the various species known under the general name "loco" are among the first plants to appear on the ranges and in the Southwest are responsible for more damage to live stock than any other group of plants. In addition to the loco plants hitherto recognized as harmful it has been found that a species which causes serious losses of cattle in Arizona is the so-called "sheep loco" (*Astragalus nothoxys*).

In addition to the toxic alkaloid of *Dicentra cucullaria*, the discovery of which was reported last year, another new toxic alkaloid has been found in *Dicentra canadensis*. There is a marked difference in the toxicity of these two plants, *D. canadensis* being about one-sixth as toxic as *D. cucullaria*, the species which has often caused losses of cattle in the mountain pastures of Virginia.

Further study has been made of *Ornithogalum umbellatum*, the plant which had been reported as poisonous to sheep in eastern Maryland. From evidence collected in the field it now seems improbable that this plant was the cause of the poisoning, as originally reported. Investigation has shown that the plant contains a compound which is very toxic when introduced into the circulatory system of small animals, but is apparently harmless when administered by mouth.

Considerable variation has been found in the hydrocyanic-acid content of selected individual plants of *Lotus corniculatus*. Some of the individual plants tested were free from hydrocyanic acid, but among others the content of this acid ranged from 0.006 to 0.07 per cent. If the propagation of acid-free strains of this species should prove to be feasible, it will be possible to extend materially the use of the plant as a forage crop.

## COTTON.

*Problem of utilizing superior varieties of cotton.*—Experience with cotton has shown that the utilization of superior varieties is a fundamental problem, requiring careful study. On account of the present organization or lack of organization in the cotton industry, most of the seed is inferior, and there is no assurance of any general utilization of good varieties. Methods of breeding and acclimatization have been developed and demonstrated, but other requirements must be met if a full utilization of superior varieties is to be secured. The discovery and development of a series of superior varieties, including the Lone Star, Trice, Columbia, Meade, Durango, and Acala, make it possible to place the different regions of the Cotton Belt on new planes of improved production, and all these varieties are being grown as extensively as the available supplies of good seed will permit; but the inadequacy of the present systems of providing annual supplies of planting seed is also being recognized and methods of improvement devised. Efforts are being made, therefore, to avoid the general mixing of seed at the public gins and the crossing of the different varieties in the fields, which undoubtedly are responsible for the rapid and general deterioration of seed stocks that tend to keep our producing industry on a low plane of efficiency.

*One-variety cotton gins.*—Though the mixing of seed of different varieties at public gins is a fact very familiar to cotton growers, the nature, extent, and results of such mixing are not generally understood. In connection with seed-breeding work, methods have been devised for testing, demonstrating, and determining carefully the extent of the mixture that actually takes place in the ordinary course of public ginning when a farmer gets a bale of cotton ginned following a different variety. The results of such experiments show that the most modern and mechanically improved gin plants are mixing the seed on a scale even larger than before. A recent publication of the results of a series of experiments with modern gin equipment shows an admixture in the first bale of about 26 per cent from seed of previous customers held over in the gin machinery. Even the second and third bales are contaminated, so that the average farmer has no prospect of keeping his seed pure if he patronizes a regular public gin and does not take the precaution of having the machinery thoroughly cleaned, which is difficult and expensive.

The only simple, practical, and really effective method of avoiding the mixture of cotton seed at public gins is to organize the production of the surrounding community so that only one variety of cotton is brought to each gin. Where different varieties are planted in neighboring fields and taken to the same gins it is out of the question to keep the seed pure. Lack of pure seed is responsible for a general failure to utilize superior varieties of cotton and for enormous industrial and economic wastes through the production of inferior fiber and the manufacture of weak, perishable fabrics. A system of one-variety cotton gins is being developed in several communities in Texas that are specializing in the production of superior varieties and selling their seed as well as their cotton fiber at higher prices.

*Advantages of community cotton production.*—Study of the pure-seed problems leads inevitably to the recognition of community production as a practical ideal of cotton improvement. Mixture and degeneration of seed can be avoided if only one variety of cotton is grown in each community or district. Keeping varieties pure and developing adequate supplies of pure seed are community problems which individual farmers are practically helpless to solve for themselves under the usual conditions of production. Cooperation to the extent of agreeing to plant the same variety of cotton is necessary if farmers are to have regular supplies of pure seed for their own use or to sell. The fiber also becomes more valuable, because the precautions that are necessary to keep the seed pure are effective at the same time in keeping the staple more uniform. Manufacturers are willing to pay more for uniform fiber, especially if commercial quantities are obtainable in the same district. Through community action it is possible to observe the necessary precautions, so that superior varieties can be preserved, increased, and utilized. This has been demonstrated in the striking progress made in recent years in the Salt River Valley of Arizona, where the growers have specialized in a single variety.

*Requirement of uniformity in cotton.*—Mixtures of long and short staples are worse than useless to the manufacturers and can be sold by farmers only because unskillful buyers often fail to detect even badly mixed fiber. It is much more difficult to detect the mixture of different kinds of fiber in the bale than to recognize the different kinds of plants in the field. By simple inspection of the fields it is easy for those who are familiar with varieties to see whether the plants are all of one kind or of two or more different kinds, or a miscellaneous mixture of sorts, as in the ordinary gin-run stocks. If the plants are different and produce different kinds of fiber, the staple will not be uniform in the bale. Even with short staples uniformity is important, and manufacturers would willingly pay more for really uniform fiber if assured of the "even-running quality" that is their ideal of textile raw material. Notwithstanding the importance of uniformity to the manufacturer in reducing wastes and lessening costs in factory production, little attention has been given to this problem on the agricultural side to recognize and remove the causes of uneven fiber.

*Classing cotton in the field.*—In communities or districts that specialize on one variety, as in the Salt River Valley of Arizona, the highest degree of uniformity in cotton production can be attained. In addition to guarding the purity of the seed stock, because mixing is excluded, the effects of different conditions of growth are more readily recognized when all the fields of a community are planted with the same variety. Since the effect of unfavorable conditions is to keep some of the cotton from reaching a full or normal development of length and strength of the staple, the general uniformity and value of the crop are impaired if short, weak, or "perished" fiber or cotton that is injured by bad conditions is included with the good fiber. Some of the inequality is detected, of course, by the usual commercial classing of samples drawn from the bales, but experience shows that many irregular bales are not detected until they reach the mill. If commercial classing were preceded by field inspection, a more definite basis for the certification of uniformity would be secured. The possibility of field classing was recognized several years ago, and a practical test is to be made with the crop of 1922 in the Salt River Valley.

*Getting full stands of cotton.*—Lack of a full stand is one of the most serious and general factors in restricting the production of cotton and is especially serious in Texas and in the irrigated valleys of Arizona and California.

Prompt germination of the seed in advance of the drying of the surface soil has been recognized as desirable. For this reason, as well as to avoid clogging planting machines, the delinting of cotton seed is practiced to remove the "fuzz" or short fibers from the surface of the seed. Chemical delinting with strong sulphuric acid also has been advised, with the probable advantage of disinfecting the seed as well as removing the fuzz, but no safe and practical process of chemically delinting large quantities of seed has been developed. Further investigation in this line has led to the recognition of a new possibility of delinting with gaseous hydrochloric acid. This avoids the most serious difficulties of the sulphuric-acid treatment. Exposure of the dry seed to hydrochloric acid disintegrates the lint, so there is no need of the wetting, washing, and drying of the seed that were the serious difficulties of the sulphuric-acid treatment. A public-service patent has been granted at the request of the Department of Agriculture to Mr. Loren G. Polhamus, the inventor of the process of delinting with hydrochloric acid, and efforts are now being made to develop it on a scale that can be used generally for planting seed.

*Restricted irrigation of young cotton.*—The production of cotton in Arizona and California is entirely dependent upon irrigation. The proper application of water largely determines not only the yield but also the quality of the lint, so that a knowledge of the water requirements is essential to scientific farming. Though no regular quantity or interval for applying water can be prescribed, on account of wide differences of soil and other conditions, the irrigation treatment can be adjusted to the needs of the crop by observing the behavior of the plants, as experiments have shown.

In general, cotton should be irrigated so as to keep the plants growing steadily and to avoid either forcing or checking their development. While the plants are small and not yet flowering care should be taken to apply water only as needed, since too much water may force rank growth, especially with rich soil and warm weather. It is important to establish the young plants in a normal habit of growth before the flowering stage is reached. After a normal fruiting condition is attained, the plants are not so easily forced into rank growth by the application of water, even in excess of the actual requirements, so that the summer irrigation problems are simplified.

*Irrigation of cotton in the fruiting period.*—After flowering begins water should be applied more frequently, enough to keep the plants growing and the flowers well down from the top. If the plants bloom at the top it is apparent that irrigation has been delayed too long and growth restricted. The general wilting of the plants is a sign of water exhaustion, which may cause boll shedding and injure fiber quality, but slight wilting in the afternoon of a hot day is not abnormal. A method that has been successful with Pima cotton in the Salt River Valley is to irrigate the general field when the plants in the drier spots begin to wilt in the morning. With these features to guide in applying water, a steady growth should be maintained until the latter part of August. Less water is required in September and October, but to mature the bolls properly the plants should not be allowed to wilt. A need of irrigation in the late season is sometimes shown by a decided yellowing of the plants, even though no wilting occurs.

*Cultural control of the boll weevil.*—An important step has been taken toward avoiding weevil injury in extending the use of the new method of close spacing the plants in the rows. This has been described in several publications as the "single-stalk system," calling attention to the advantages of restricting the size of the plants and controlling their habits of branching. The improved method produces upright plants with only a single primary stalk and avoids the formation of the spreading secondary stalks, side stalks, or vegetative branches which arise from the base of the primary stalks and are entirely different from the fruiting branches that bear the flowers and bolls. The objection to the secondaries, or side stalks, is that they stand out obliquely and close the lanes between the cotton rows, especially if the cotton grows too rank, as it tends to do where boll weevils are abundant. Large plants with spreading side stalks are especially undesirable under weevil conditions, because the crop is later to set and later to mature on large plants.

*Recognition of two kinds of cotton branches.*—Though the single-stalk system of cotton planting is very simple it is not easily understood by those who are not familiar with the structure and habits of the cotton plant to the extent of knowing the differences between the two kinds of branches. The differences are familiar to observant cotton growers, though formerly not recognized or interpreted by writers and teachers, so that a scientific appreciation of the control or suppression of the vegetative branches was not attained. This requirement of direct knowledge of the plant has been a technical difficulty, but now the system is being popularized rapidly through the agricultural press. It is believed that a more general knowledge and use of the single-stalk system in combination with other methods of weevil control previously suggested will render the crop more secure and tend to maintain the production of cotton over the entire Cotton Belt.

*A study of boll-weevil cotton.*—The expression "boll-weevil cotton" is used by farmers in Texas to describe a secondary effect of weevil injury, an abnormal growth that results from the plants not being allowed to set fruit because the floral buds are destroyed by the weevils. A special study of boll-weevil cotton made in Texas in the season of 1921 yielded further evidence of the abnormal behavior of the weevil-pruned plants and of the need of restricting the size of the individual plants, which the single-stalk method makes possible.

The relation between the size of the plants and the extent of weevil injury was shown to be very marked. On the exposed individual plants and the separate rows of cotton with open lanes between, bolls continued to set till late in the season, notwithstanding the great abundance of weevils and the complete cessation of fruiting in the closely adjacent fields of boll-weevil cotton. The overgrown boll-weevil cotton represents a hopeless condition from the standpoint of production, because the weevils are protected, even in dry weather, under a continuous canopy of foliage. Wider separation of the rows is indicated, but closer spacing of the plants in the rows will avoid excessive growth, suppress the vegetative branches, and keep the lanes open.

*Causes of shedding in cotton.*—Though the boll weevil is the most prominent cause of the blasting and shedding of the floral buds, or "squares," of cotton, shedding from other causes is of such frequent and general occurrence in the Southern States that some writers have considered it a normal habit of the cotton plant to shed 50 to 60 per cent of the buds. As shedding from other causes is more injurious under weevil conditions, because tending to more serious reduction of the crop, the relation of shedding to weevil resistance may be very important. Experiments in some of the irrigated districts of California have demonstrated that shedding is not normal, since it does not occur when the continuously favorable conditions are maintained, but any extreme condition may induce shedding, either by checking or by forcing the growth of the plants. Some varieties are more susceptible to shedding than others, and the Egyptian type of cotton is notably less susceptible than any of the American upland varieties thus far known. Cultural conditions that determine the size of the plants also have relation to shedding, large plants being more susceptible to injurious checking by drought in comparison with smaller plants under the same conditions.

*Possibilities of maintaining sea-island cotton.*—It has been assumed by many that the culture of the superior sea-island cotton of South Carolina could not be maintained in the presence of the boll weevil, but experiments are being made for a more definite determination of this question, and more information may lead to a different conclusion. It seems not impossible that the difficulties arising from the later maturity of the sea-island crop and its greater susceptibility to the boll weevil may be prevented by changes in cultural methods and through better organization of the industry, in order to avoid the planting of upland cotton in the same communities and thus defer the breeding of boll weevils too early in the season. The need of very early planting of sea-island cotton is avoided and a much shorter period of production made possible by closer spacing of the plants combined with rather late thinning, to get full exposure of the soil to the sun and facilitate the collection of weevil-infested squares when the weather is not dry enough to kill the weevil larvæ. A method that may prove useful under sea-island conditions is to plant in hills 15 inches apart, thinning to two plants when about 8 or 10 inches high, or after the first squares begin to form. The sea-island bolls are more delicate and suffer worse from the weevils, but possibly they can be protected by the use of poison or in other ways.

*Cotton varieties in Central America.*—An agricultural exploration in British Honduras and the adjacent districts of the Department of Peten, Guatemala, the region of the ancient Maya civilization, has resulted in the discovery of a series of additional forms of cotton quite different from any that have been recognized in other parts of Central America, but bearing a certain resemblance to the native cotton varieties of our Southwestern States as grown formerly by the Pima and Hopi Indians. Though having a general relationship to the upland cottons of our Southern States, the Peten and British Honduras cottons are distinct in numerous characters. The seeds as well as the bolls are much smaller, though the lint is of good length and quality, and the plants are prolific and possibly resistant to drought. The severity of the dry-season conditions in this region may account for the absence of the boll weevil, which was not found on any of the native cotton in this district, unlike the neighboring Department of Alta Vera Paz, Guatemala, where weevils are known to exist.

*Egyptian cotton breeding.*—Cooperation with the associated growers of Pima cotton in the Salt River Valley, Ariz., in maintaining a supply of pure planting seed has been continued. The introduction of other types of cotton in this community has increased the importance of close attention to the seed supply. Experimental evidence has been obtained that the Pima variety has remained unchanged genetically and has suffered no loss of uniformity since the first commercial plantings were made in 1916. Occasional complaints by consumers of increasing variation in the fiber are unquestionably attributable to increased diversity in the soil and in cultural practices resulting from the expansion of the acreage.

Breeding work with the Egyptian type of cotton is being continued with the objects of developing a more productive and smoother seeded strain of the Pima variety and of combining by hybridization the desirable characteristics of Pima and Sakellaridis, the latter being the finest variety grown in Egypt and the principal competitor of Pima in the long-staple cotton markets. The hybrids thus far obtained are uniform and possess desirable fiber properties but show the marked lack of fruitfulness which characterizes the Sakellaridis variety when grown in Arizona.

### FIBER PLANTS.

In the work of fiber-plant investigations emphasis has been placed on the future production of fibers for binder twine, the maintenance of supply and improvement in quality of abaca (Manila hemp), and the improvement of varieties of flax and hemp.

*Binder-twine fibers.*—The cooperative work with the Philippine Bureau of Agriculture to encourage the production of machine-cleaned sisal and cantala fiber in the Philippine Islands is resulting in a steadily increasing production of these fibers.

The machine-cleaning demonstrations conducted during 1918 and 1919 with Government-owned machines were followed by the establishment of machine cleaning on a commercial basis. During the calendar year 1920 the Philippines produced 707 bales of machine-cleaned fiber; during 1921 the production amounted to 5,138 bales; and during 1922 the production has been in excess of 1,000 bales per month. With the maintenance of the present rate of production the Philippines during the calendar year 1922 will produce approximently 4,000,000 pounds of machine-cleaned binder-twine fiber, or a supply sufficient to provide binder twine for 2,000,000 acres of grain crops.

The quality of the Philippine machine-cleaned fiber, which was unsatisfactory when machine cleaning was first established in the islands, is now showing a marked improvement. The production of the two highest grades of cantala fiber, grade "A" and grade "B," has increased from 37 per cent of the total during the first six months of 1921 to 76 per cent during the first five months of 1922. Philippine machine-cleaned cantala and sisal fiber is now regarded by the Government inspectors in Manila as superior to the average Mexican current sisal.

The gradual substitution of sisal for cantala in those districts of the Philippine Islands where climatic and soil conditions are adapted to sisal has been recommended by this bureau. In earlier years sisal plants were imported into the Philippines from the Hawaiian Islands; during 1920 the Department of Agriculture fiber-cleaning machine was placed in a sisal-producing district of the island of Siquijor; and in October, 1921, the Philippine Bureau of Agriculture officially recognized machine-cleaned sisal as a fiber separate and distinct from cantala. Sisal has now obtained a fairly substantial foothold in the Philippine Islands, and the average monthly production of machine-cleaned sisal has increased from 32 bales in 1921 to 120 bales during the first five months of 1922.

The unsettled industrial and political conditions in Yucatan together with the marked reduction in the production of henequen fiber there serve to emphasize the advisability of encouraging in every way possible a continued increase in the production of binder-twine fiber within our own territory.

*Abaca (Manila hemp)*.—The annual consumption of abaca fiber in the United States is approximately 500,000 bales. There is no satisfactory substitute for this fiber, and with the exception of a few hundred bales the entire world supply of abaca is produced in a few Provinces in the Philippine Islands. Under these conditions, the welfare of the Philippine abaca industry becomes a matter of direct concern to every industry in this country that uses any form of manila cordage in its operations.

The principal efforts in the work with abaca have been (1) to maintain a close contact with the producers of abaca and the Government fiber inspectors in the Philippine Islands and with the fiber brokers and manufacturers of abaca cordage in this country, (2) to encourage and support the work that is being done by the Philippine Bureau of Agriculture to maintain the production of an adequate supply of abaca fiber that is of satisfactory quality, and (3) to conduct investigations in the Canal Zone and Panama with a view to the establishment of the abaca industry in tropical America.

In certain respects there has been a marked improvement in the general abaca situation during the year. Production, which declined nearly 50 per cent during 1921, is again nearly normal. The large stocks of old, deteriorated fiber in Manila, the ultimate disposition of which was a very serious problem, have been reduced by more than 100,000 bales. The average quality of the abaca fiber produced during the year 1921–22 has been maintained at a higher standard than that of the previous year. In the maintenance of this standard of quality and in encouraging the disposition of the stocks of old fiber, the work of the Philippine Bureau of Agriculture has been an important factor. The fact remains, however, that the abaca planters are now receiving for their fiber prices that barely cover the cost of production and that the abaca industry in the Philippine Islands is in an unstable, if not precarious, condition. Unless there is some improvement in the near future there can be no doubt that many planters will replace their abaca with coconuts and other crops.

An investigation has been made during the year in the Canal Zone and Panama for the purpose of ascertaining whether it is advisable to attempt the production of abaca in these regions. The conditions of soil and climate in the Canal Zone, while not entirely favorable, are such as to justify experimental nursery planting. The conditions in the eastern part of the Republic of Panama indicate that abaca can be produced on a commercial scale in that country. Preliminary arrangements have been made with the proper Government officials in the Canal Zone for the establishment of nurseries, and negotiations are in progress for obtaining the required propagating stock in the Philippine Islands.

It has been ascertained that the so-called Manila hemp now cultivated in Panama is not one of the recognized varieties of *Musa textilis*, but is a plant that closely resembles the wild banana of the Philippine Islands. The wild banana when grown in the Philippines produces a fiber greatly inferior to abaca. As the more or less general belief that abaca fiber of satisfactory quality can be produced only in the Philippine Islands is based, in part at least, on a knowledge of the inferior fiber produced by these plants, which were supposed to be abaca, this information has an important bearing on future experimental work with abaca.

### SUGAR CANE.

Sugar-cane mosaic attacks sorghum, corn, several species of wild grasses, and probably other plants. It has been transmitted from plant to plant by artificial means and also by the corn aphis in the sugar-cane greenhouse of the bureau. The mosaic does not remain in the soil and hence may be eliminated from a field by careful and thorough roguing, provided all other hosts are likewise destroyed.

A plant diseased with sugar-cane mosaic does not recover; hence the disease will remain and be a possible source of infection as long as the plant is alive. The destruction of diseased plants and the use of healthy seed cane are the only known methods by which sugar-cane mosaic may be eliminated.

Mosaic has been found in each of our cane States, and every field has been inspected and the degree of infection, if any, has been determined and recorded. Some of the States are cooperating in the control of the mosaic in the cane areas. The disease has been reduced practically to the point of elimination in parts of Porto Rico and in the eastern and peninsula part of Florida, where the roguing advocated by the bureau has been practiced according to directions. The immune variety of cane, Kavangire, imported by the bureau from Argentina in 1919, is being rather generally planted and in badly diseased areas promises to displace the susceptible varieties.

## FRUITS.

### CITRUS FRUITS.

*Grapefruit ripening and storage.*—Because of the fact that the great bulk of the grapefruit crop is marketed during a comparatively short period and because of certain serious difficulties which have been experienced in holding this fruit in cold storage, considerable work has been done in an effort to determine satisfactory methods of handling the fruit and to learn the limits of storage. Successful storage obviously has large possibilities, in view of the fact that by holding the fruit in cold storage for a considerable length of time the marketing period would be extended, thereby making grapefruit available to the consumer over a longer period and at the same time tending to eliminate gluts in the market which are likely to result from the present necessity of disposing of the crop in a limited time.

The results of the work have been very promising. The procedure has been to procure fruit from individual trees at different times and to handle comparable lots differently, both during the prestorage period and while in storage. Chemical analyses of the fruit have been made from time to time in order to determine the biochemical effect of different methods of handling and storing, as well as for the purpose of gaining information in regard to the biochemical processes that go on in different fruits from the time they are harvested until they are consumed. The chemical analyses show that grapefruit behaves very much like deciduous fruits when in cold storage so far as chemical changes are concerned. The acids seem to break down, while the sugar content remains about the same. In warm storage, however, the sugar seems to disappear and the acids to increase to some extent. One of the serious problems in the storage of grapefruit is the development of what is commonly called "pitting." This is the breaking down of certain cells in the skin of the fruit, which results in the formation of brown-colored pits that may be very numerous and may increase in size until many of them coalesce. This produces a very unattractive appearance. It has been determined as a result of this line of work that grapefruit cured at a temperature of 60° to 65° F. in a humidity of about 55 per cent, the curing being continued from 10 to 20 days, and then placed in a storage temperature of 32° F. may be kept in good condition for two months, thereby materially extending the marketing period. Fruit so handled does not suffer from pitting and comes from storage in an attractive condition with excellent dessert quality. The results of this work have been published in two papers in the Journal of Agricultural Research.

*Conditioning citrus fruits.*—The fact is becoming accepted that some citrus fruits reach their highest edible quality before their color changes from a chlorophyll green to the orange or yellow shades which the consumer and the public generally have come to associate with a citrus fruit in good edible condition. If such fruit is allowed to remain on the tree until the desired color appears, it may lose in edible quality, and it may lose the advantage of an earlier market. This is true particularly of Satsuma oranges and one or more early-ripening varieties of oranges grown in Florida. Considerable attention has therefore been given to the working out of practical methods of accelerating the development of a ripe color in such citrus fruits. While this work has been in progress for several years, its commercial application has been given particular attention during the past year. The method of procedure is to confine the fruit in a compartment which can be made practically air-tight and to subject it to the products of incomplete combustion of kerosene or gasoline. The effect of these products on the color of the fruit is to change the green shades to the orange or yellow shades which would develop normally at a much later period. This change of color is brought about in three to five days. The work with Satsuma oranges has been carried on in cooperation with the Gulf Coast Horticultural Society and the Gulf Coast Citrus Exchange. This method of treating Satsuma oranges has been adopted on a somewhat extensive scale. Nine packing houses in Alabama have been equipped with conditioning rooms, and about two-thirds of the crop of 1921 was treated in this way. This has enabled the growers to complete the marketing of their crop about four weeks earlier than would have been the case otherwise. This is of importance commercially, because if left to color naturally some of the fruit would have been overripe and insipid in flavor. The best marketing conditions for this type of orange prevail earlier in the season than can be taken advantage of when the fruit is allowed to color on the tree, and by this accelerated coloring the full advantage of the best marketing period can be realized.

The conditioning of oranges in Florida, also of one variety of grapefruit, was begun in a small way last season, but during the winter of 1921–22 work along this line was actively inaugurated in that State, and the process was rapidly adopted by a considerable number of the Florida citrus growers. The Parson Brown orange and the Davis grapefruit were the varieties to which the process was principally applied, although tangerines and Valencia oranges were also treated. In all, about 300 cars of citrus fruit thus treated were shipped from California during the winter of 1921–22. This fruit brought about $1 a box more than fruit from the same groves which was of greenish color. Tangerines which after conditioning were put on the market for the Thanksgiving holiday trade sold as high as $9 a half strap. About 10,000 boxes of Valencia oranges which were conditioned brought from $1 to $2 more per box than the same grade of fruit which was shipped as it came from the trees. About 100 conditioning rooms have been erected in Florida. This work now seems to be on a sound commercial basis in Florida and in Alabama.

*Citrus improvement through bud selection.*—The investigational individual tree-performance records with the Washington Navel, Valencia, and Ruby Blood orange varieties, Lisbon, Eureka, and Villafranca lemons, Marsh grapefruit, and Dancy tangerine have been continued during the calendar year 1921.

Several outstanding and important facts have been brought out clearly during the past year in connection with the investigational citrus progeny performance-record work. Buds taken from the normal branches of the parent tree where that tree has a sporting branch or branches bearing abnormal fruits or foliage produce trees which have been found to be extremely variable and undesirable for commercial propagation. In other words, parent trees which have sporting branches as the result of bud variation have been found to be undesirable for propagation, even though the buds for propagation are taken from the normal branches of such trees. The variable branches in the trees indicate inherent instability. On the other hand, buds taken from productive and normal trees bear fruits uniformly good and without marked deviation from the normal type of fruits and foliage. This discovery, confirming similar investigations during previous years, has demonstrated that in the selection of parent trees for propagation it is essential that only those trees which produce uniformly good fruits be used.

One illustration of the nature of the progeny performance records will suffice. From two especially desirable Lisbon lemon trees 325 trees each were propagated in 1912. These two parent trees were the most productive and desirable in a 10-acre Lisbon orchard on the Limoneira Ranch in Ventura County, Calif. The trees were planted in orchard form in 1914. A systematic record of their performance was begun in July, 1917. During the six months following, the average yield was 7 boxes per tree. For the calendar year 1918 the yield for these 650 progeny trees was 2½ boxes per tree. There was an annual increase up to and including the crop of 1921, the average for that calendar year being 7⅖ boxes per tree, or more than double that of the ordinary tree of the Lisbon variety when grown under similar cultural conditions where no selection of budwood for propagation is practiced.

*Satsuma oranges.*—As a result of investigations of Satsuma oranges being grown in Japan, a number of introductions of new varieties have been made, and propagation of these is being pushed in order to test them thoroughly in the United States. The Wase variety, originating as a bud sport of the Owari variety, possesses the merit of unusual earliness combined with large size and excellent quality.

*Citrus-canker eradication.*—As a result of the vigorous campaign conducted by the Gulf States in cooperation with this bureau it was thought that the bacterial disease of citrus trees known as citrus canker had been completely eliminated from areas of commercial citrus-fruit production, but this canker was again discovered in Florida on May 20, 1922, in a grapefruit orchard in an isolated citrus section near Davie, and since that time 14 near-by properties have been found infected, with a total of about 750 trees. Since the disease is easily spread from orchard to orchard by workmen engaged in cultivating or picking, a rigid inspection is necessary, and a large corps of men experienced in canker control is now at work in Florida.

In addition to this outbreak in Florida a few infected spots were found in Alabama and Mississippi, which emphasizes the necessity of continuing the inspection work on a more adequate scale. Louisiana has apparently eradicated canker from the commercial producing area, but many scattered infected trees are being found in isolated places. Effective eradication activities are now under way in Texas, and it appears that by far the larger part of the infected trees have been located and destroyed. Occasional outbreaks of canker occur in the lower Rio Grande Valley, and at present major efforts are being devoted to the thorough eradication of canker from the entire Rio Grande district.

*Melanose and stem-end rot.*—Further experiments confirm the previous findings that spraying young fruit with Bordeaux mixture and oil emulsion in combination will effectively and economically control both melanose and stem-end rot. This gives a new and probably the most satisfactory way of handling the very difficult stem-end rot situation as it originates in the orchard. Researches have been continued on the stem-end rot as it occurs in the packing houses and in transit, and extensive data on the activities of the causal fungus are ready for preparation for publication.

### ROSACEOUS FRUIT BREEDING.

The principal activities in breeding rosaceous fruits have been carried on in California, centering about Chico. In view of the fact that the work has been in progress only a comparatively short time, no final results can be reported, since there has not been a sufficient time for any of the seedlings resulting from this activity to come into bearing. Special consideration is being given to the stone fruits, particularly peaches and plums, with some attention to pears. The effort is to combine in hybrids, or crosses, certain horticultural varieties having important desirable characteristics with other varieties or species, or with introductions made by this bureau, with a view to obtaining combinations which will represent new qualities or improvement such as will render the varieties produced of particular value for special purposes or for regions where the present varieties are not well adapted.

Cooperative relationships have been established with the Leland Stanford University whereby that institution has set aside an area not to exceed 20 acres of land, on which, as the needs of the work grow, the seedlings resulting from the breeding work will be planted, and certain special material desired for use in this work not obtainable elsewhere will be planted and grown under conditions that will make it most readily available for use. The change of location from Chico to Palo Alto places the headquarters for the breeding work in a section where there are large deciduous-fruit interests, a section which is very much more favorable for the growing of the material resulting from breeding than was the case at Chico. It is felt that this arrangement will prove of far-reaching value to the work.

### APPLES.

Apple scab was introduced into the United States from Europe, being first noted in New York and Pennsylvania about 1834, whence it spread over the northern apple section. It is still spreading in this country, particularly in the newer apple sections of the West. Scab is probably the most serious disease of apples with which growers have to contend. In 1920 it caused an estimated loss of 6 per cent of the apple crop, or 7,000,000 bushels. During the present year, 1922, this disease is epidemic in some sections on account of the wet season, and the losses to the apple crop will exceed those of 1920. Proper spraying with lime-sulphur solution is well known to be an effective remedy for this trouble.

### DATES.

The prospect of soon being able to obtain plants of the best-known varieties of dates adapted to American conditions has relieved the pressure for nursery stock of indiscriminate character, and what appeared to be a critical danger—the extensive planting of inferior varieties—seems now to be fairly well passed. The fact, too, that under the contracts made with persons handling the imported offshoots the increase can only be sold at specified maximum figures for each variety has also tended to stabilize the nursery end of the date industry.

### STRAWBERRIES.

Strawberry breeders in the United States will be interested in the recent introduction from Ecuador and Chile of several horticultural forms of *Fragaria chiloensis*, the Chilean strawberry. This species was introduced into Europe in 1714 and took part in the development through hybridization of the present-day garden strawberries. Previous to the department's recent investigation of the subject, no adequate study had been made of the cultivation of this berry in South America, where it forms in certain regions an important culture, nor had several choice strains which are there cultivated been introduced into the United States for the use of plant breeders. By combining these with the horticultural forms now grown in this country new strawberries of superior shipping quality, drought resistance, and flavor appear likely to be secured.

### BLUEBERRIES.

Distinct progress has been made in the breeding of superior varieties of blueberries. About 25,000 hybrids have now been fruited in the testing plantation at Whitesbog, 4 miles east of Browns Mills, N. J. Many of them have produced berries three-fourths of an inch in diameter, several four-fifths of an inch, and one of them this year reached almost seven-eighths of an inch. Among these large-berried hybrids several have been selected for propagation. The progress of blueberry culture is evidenced by the fact that during the season of 1922 nearly a thousand bushels of blueberries were picked at Whitesbog and that these sold in the open market in New York at prices about 75 per cent higher than those of wild blueberries. In the fall of 1921 more than 250,000 cuttings of selected blueberries were made by nurserymen.

### AVOCADOS.

It is becoming more and more evident that the future of avocado growing in the United States depends in large measure upon securing good commercial varieties which are more frost resistant than most of those now cultivated in California and Florida. One of the most promising methods of producing such varieties is by plant breeding; another is the introduction of the hardiest commercial sorts from high elevations in tropical America. The bureau has lately introduced from the mountains of Ecuador several choice varieties of the Mexican avocados which seem likely to prove of real value. In addition, every effort is being made to aid plant breeders engaged in developing new forms through hybridization by supplying them with other material of this nature, including the hardy wild relatives of the avocado and superior varieties of the Guatemalan race which may be utilized in crossing with hardy forms of the Mexican to produce forms combining hardiness with good commercial characteristics.

## NURSERY INVESTIGATIONS.

In view of the fact that this country has been so dependent upon foreign sources for many of its fruit stocks, an attempt has been made to find out whether American sources of seed and American-grown stocks may not be produced which will have all the merits of the imported stocks. Furthermore, the fact has been impressing itself more and more that the wide seedling variation in the stocks that were in general use must have a very much greater influence on the merits of the trees propagated on them than has been supposed. The desirability of vegetative propagation of the better stocks is therefore assuming much importance.

### APPLE-STOCK EXPERIMENTS.

In comparing the development of American-grown and foreign-grown apple seedlings, representative lots were secured from practically all the sources that were available. For example, sample lots of imported French crabs were obtained; also French crab seedlings grown in Kansas and in Iowa; seedlings from Minnesota-grown seed raised in Minnesota; seedlings from Minnesota-grown seed raised in Kansas; and corresponding lots from Vermont, Pennsylvania, and various other sources. These seedlings are all being grown at the Bell station and their development carefully observed. Seedlings of some of our commercial varieties of apples produced an apparently satisfactory type of stock for commercial purposes, but there is a very wide variation in the character of the seedlings of the different varieties. The development of this fact may have an important bearing on sources of seed in this country for use in the growing of stocks. Possibly, however, the most important development and the one that promises to have the most far-reaching effect on the whole stock situation is the comparative readiness with which many varieties can be propagated from root cuttings. Apple-root cuttings as a rule send up several sprouts, and by mounding up the sprouts as they grow an abundance of roots develops from each sprout. After these have rooted they can be separated from the original root cutting, lined out in the nursery row, and grown independently. These shoots develop rapidly, and there appears to be no reason why they can not be handled just as seedling stocks are handled so far as their use in propagating apples is concerned. In this way the original root cuttings can be continued year after year as a source of new sprouts. This method of propagation also has promise as a means of propagating apple varieties directly on their own roots.

This method of vegetative propagation is receiving possibly more attention than any other one feature of the stock investigations because of its promise for the industry.

## ROSE-STOCK EXPERIMENTS.

The line of investigation with apple stocks is being followed on a limited scale with other fruits. It is also being employed in the rose-stock investigations as well as in a limited way with orange stocks. In the rose-stock work some of the stocks in common use are being grown and used in propagation for comparison, but there is much promise in some species that have not heretofore been used in rose propagation. These are represented by species and varieties of roses brought together by the late Dr. Walter Van Fleet. Of these new stocks which look especially promising there may be mentioned the following:

*Rosa multiflora cathayensis*, a very hardy rose of the multiflora type, which propagates readily from softwood and hardwood cuttings and develops a very vigorous root system; *Rosa odorata*, introduced from China by the Office of Foreign Seed and Plant Introduction, which propagates readily by softwood and hardwood cuttings; *Rosa souleana*, introduced from northern Chosen (Korea), which can be propagated from seed which germinates the first year and also from softwood cuttings.

Other stocks which look promising are a *setigera-wichuraiana* hybrid of Doctor Van Fleet which propagates readily from softwood cuttings, a *jackii-wichuraiana* hybrid, *Rosa multiflora polyantha*, and a vigorous-growing type of *Rosa multiflora*. In addition to these promising new stocks, the experiment will include stocks which are now in use commercially, namely, manetti, canina, Madame Plantier, Seven Sisters, Wax Rose, Ragged Robin, *Rosa cinnamomea*, *Rosa setigera*, and *Rosa rugosa*.

While the larger part of the investigations is carried on at the Bell station, work on a smaller scale has been located at the South Haven substation of the Michigan Agricultural Experiment Station, in cooperation with the latter, and at Norfolk, Va., in cooperation with the Virginia Truck Experiment Station.

## VEGETABLES.

### POTATOES.

*New varieties.*—From the high Andes of Colombia and Ecuador a considerable series of interesting potatoes has been introduced for the use of North American plant breeders who are working with this crop. This series includes a number of varieties of the chaucha group, a very early maturing type from Ecuador; the yellow-fleshed potato, a variety of remarkably rich flavor from Colombia; and one or two wild forms closely allied to the cultivated potato and of possible value for hybridizing with the latter.

*Improvement of seed stock.*—About 5,000 new seedlings obtained in the breeding work are under test, together with a considerable number of the most promising selections made from earlier breeding work. In this phase of the work the difficulty is to get in a single combination high yield, high table quality, resistance to disease, and the other important characteristics of shape, smoothness of surface, etc. In many instances seedlings that are highly resistant to disease have proved to be light-yielding sorts and have lacked in table quality or in some other particular, while other seedlings which have had great promise in some other line have proved susceptible to disease. The work is continued in the expectation that through a combination of varieties of seedlings having desirable characteristics in the largest degree seedlings will eventually be secured in which these characteristics are all combined in a satisfactory measure.

Perhaps the most immediately important and far-reaching activity is that having to do with the improvement of seed stock. By bringing together at certain places sample stocks of the seed supplied of the different varieties which are largely grown for commercial purposes and testing them under uniform conditions, it becomes possible to determine what strains or selections are the most nearly free from disease and give the best yield. Through this method of testing under uniform conditions it is found that many of the commercial seed potatoes supplied, even where the stock has been certified, are more or less seriously diseased; and, further, there is a very wide difference in the yield of different strains or different selections of the same variety. For example, at Baton Rouge, La., where Nebraska dry-land-grown Triumph seed stock was compared with locally purchased seed of the same variety, the former showed an increase of nearly 96 per cent in the product as compared with the locally grown seed. Nebraska irrigation-grown seed gave an increase of nearly 73 per cent, and Wisconsin-grown seed an increase of more than 82 per cent over locally grown seed. The assembling for testing and the selection of the highest yielding strains and those that are the most nearly free from disease can be carried on cooperatively with much greater effectiveness than in any other way. By arranging cooperative activities in this phase of the potato work with the experiment stations that are located in the important potato-producing States a local interest is created, and many more growers are able to see for themselves the results of proper selection of seed stock than would be possible if this work were done in a single location.

*Mosaic and leaf-roll of the potato.*—Investigations of the so-called degeneration diseases—mosaic, leaf-roll, and related troubles of potatoes—which have been in progress for several years, show that this group of maladies has become the greatest handicap to potato improvement and causes great loss to producers throughout the country. The outstanding feature of the results secured is the discovery that aphids are the most effective natural means in the transmission of these diseases. In addition, it has been found by an investigator at the Maine Agricultural Experiment Station that the principal overwintering host of the potato aphis is the rose. Last season's observations indicated that both streak and curly-dwarf are closely related to mosaic and similar diseases of the potato, being frequently associated with them in the field and capable of transmission from diseased to healthy plants by juice transfer. Observations have also shown that the symptoms of mosaic vary considerably on different varieties under different climatic conditions and at different periods of the season. Plants becoming infected during the latter part of the growing season, when growth has practically ceased, will not exhibit any of the symptoms of mosaic, but the tubers from such hills will produce infected plants the following season, the disease being more severe if the affected stock is planted in the South. Last season's experiments on the control of mosaic by roguing confirm previous results, showing that roguing under ordinary field conditions, with mosaic plants in adjoining plats, will not free such stock from the disease but will tend to reduce the percentage of diseased plants, provided it is done thoroughly and continued throughout the season. Roguing stock in localities where the percentage of mosaic and aphid infestation is low has resulted in reducing the mosaic from 10 per cent to 1 or 2 per cent in one season. Different varieties react differently to the disease, but there is less resistance than was formerly thought, and it is necessary to know the foliage reaction of each kind.

## NEW VEGETABLES.

Work on the introduction and establishment of the dasheen, chayote, and tropical yams has been carried forward vigorously, and many experimenters have been supplied with material for propagation. The market for dasheens is growing, not only among our foreign-born population who have been familiar with these vegetables in their early homes but also among native Americans. Commercial shipments totaled about 10 carloads last season. A strong demand for tropical yams has developed since their importation was prohibited in 1918, and the problem now is to secure the best varieties for cultivation in this country and to find farmers who will grow this crop on a commercial scale. Cultivation is limited to Florida and adjacent States. When properly prepared, the greater yam (*Dioscorea alata*) is so similar to the white or common potato that an important future is predicted for it in all those regions where it can be grown successfully. About 350 persons are this year growing yams, experimentally and for market, from propagating material supplied by the department. The chayote, a subtropical vegetable of the squash family, is now produced in commercial quantities in some of the Southern States, and the department is cooperating with dealers in northern cities who desire to bring this new vegetable to the attention of the American public.

### CUCUMBER MOSAIC.

The investigations of cucumber mosaic during the past year were along lines developed as a result of the work of previous seasons. It has been proved that the common milkweed is an important source of mosaic infection for cucurbits in the field and is probably more important than the wild cucumber as a source of infection in many localities, because the milkweeds are found in the immediate vicinity of cucumber fields, while the wild cucumbers are often at such distances from the fields that infection is not certain to occur in all seasons. If aphids are present in the fields the proximity of the milkweed plants is almost certain to result in infection of the cucumber crop, since the aphids feed on both the cucumber and milkweed.

## PLANT NUTRITION.

### QUALITY OF IRRIGATION WATER IN RELATION TO IMPERMEABLE SOILS.

It has become increasingly apparent that the quality of the water used in irrigation is an important factor in the success or failure of agricultural production on irrigated land. On many of the older irrigated areas and even on some of those but recently put under irrigation extensive tracts of land have become relatively unproductive because of troubles associated with the accumulation of the so-called alkali salts. These difficulties are sometimes manifestly due to alkali; that is, to the fact that the quantity of soluble salts in the soil is so great that the soil solution becomes too concentrated to permit crop plants to grow. It has been found also that the alkali salts have other injurious effects, particularly as regards the movement of water through the soil.

In view of the fact that the application of irrigation water continually adds soluble salts to the soil it is important that some of the water applied should percolate through the soil to carry away the dissolved salts. Unless this occurs it is inevitable that salt will accumulate in the soil as a result of irrigation. A system of irrigation practice to be continually successful requires that the soil be kept in such a condition that the irrigation water may readily percolate into it and at least a part of the water pass on through the surface layers of soil to carry away the dissolved salt.

It has been demonstrated by investigational work, both in the laboratory and in the field, that the permeability of the soil to water is influenced by the quality of the irrigation water with respect to its dissolved salts. When the dissolved salts are chiefly salts of calcium and magnesium the effect on the soil is to keep it permeable to water and thus to prevent the accumulation of salts in harmful quantities if sufficient irrigation water is applied to leach the surface soil, at least occasionally. On the other hand, if the dissolved salts in the irrigation water are chiefly salts of sodium, the effect on the soil is to make it colloidal, in which condition it absorbs water so slowly that the leaching out of the dissolved salts is difficult or impossible.

In the light of these results it has been possible to recommend the treatment of irrigated land to prevent injury when the irrigation water is deficient in calcium and magnesium salts and to correct conditions of impermeability that have developed.

The application of calcium sulphate, or gypsum, in small quantities serves to prevent the injurious effects on the soil of the irrigation water that is deficient in calcium and magnesium salts. The same treatment is often beneficial, slowly and to a limited extent, in correcting conditions of impermeability that already exist. When the condition of impermeability is serious the action of the gypsum is often very slow, because of the fact that it is not very soluble. For such conditions it has been found that aluminum sulphate is more effective than calcium sulphate in flocculating the soil colloids and making the soil more permeable to irrigation water.

It may be remarked that the calcium-sodium ratio of a stream is a much more constant factor at any given point than is the total salt content. When irrigation water contains more sodium and potassium than calcium and magnesium, there is danger that its continued use may cause the land to become hard and impermeable to water. Some of the important supplies of irrigation water in the United States carry more sodium and potassium than calcium and magnesium, and difficulties of hardness and impermeability of the soils are developing from the use of such water.

## RELATION OF SOIL SOLUTIONS TO THE GROWTH OF PLANTS.

In the field study of the comparative effects of different crop plants on the yields of other crops following in the rotation, some notable differences have been obtained in the "carry over" or residual fertilizing effects of hairy vetch, crimson clover, cowpeas, and soy beans on the small grains when tobacco, potatoes, and corn are the intervening crops. Moreover, in these and in other cropping combinations the generally unfavorable effect of corn, as compared with potatoes and tobacco, on the yields of crops following in the rotation has been a striking feature. These "crop effects" do not seem to be fully explainable on the basis of relative draft on the soil's supply of plant-food elements. For example, the tobacco crop removes much larger quantities of the plant-food elements than the potato crop, but better yields of potatoes are obtained after tobacco than after potatoes themselves.

The nutrition of plants from the standpoint of ionization phenomena has been investigated, and the results indicate that plants are not restricted to the concentrations of the soil solutions in immediate contact with the roots or brought to the roots by the movement of water, but may draw upon concentrations of solutions located at some little distance from the roots.

Other results of interest are that wheat plants make a more satisfactory growth with an intermittent food supply than when the supply is continuous, that pure ammonia is very toxic to the growth of wheat seedlings, a fact that has a bearing on the deleterious effects often noted from the use of fresh manure, and that the phosphorus in raw rock phosphate is made available by the presence of carbon dioxid. This last fact furnishes an explanation of the beneficial results of combining manure with raw rock phosphate, the bacteria of the manure liberating the necessary carbon dioxid.

### CHLOROSIS DUE TO MAGNESIUM DEFICIENCY.

In further work on the significance of magnesium as a constituent of fertilizers for tobacco and other crops it has been found that corn, like tobacco, develops characteristic pathological symptoms on certain soils when magnesium is omitted from the fertilizer. It has been discovered also that a proper balance between the supply of magnesium and sulphur in the fertilizer or soil is a factor of importance in plant growth and that this balance is likely to be greatly affected by the amount of the seasonal rainfall. In relatively dry seasons symptoms of sulphur deficiency are more evident, while in wet seasons magnesium deficiency becomes more acute, probably because of the sulphur brought into the soil by rain in conjunction with the loss of magnesium by leaching. As a result of field-plat tests carried out in most of the important tobacco-growing sections, in which chemically pure salts were used instead of the usual commercial-fertilizer materials, it has become evident that under certain conditions magnesium deficiency may result in serious damage to tobacco, even on newly cleared land, and the crop is subject to injury from this cause in various localities. It has been demonstrated that the necessary quantity of magnesium for correcting this deficiency may be readily supplied by using in the fertilizer potash salts containing appreciable quantities of magnesium or by the application of magnesian limestone to the soil. It is obvious, therefore, that the element magnesium must be taken into account both in the general problem of liming and in the proper choice of commercial-fertilizer materials, particularly in the use of highly concentrated fertilizer formulas.

### DEVELOPMENT UNDER ARTIFICIAL LIGHT.

Continuing the investigations on the effects of the relative length of day and night on plant growth, fairly extensive experiments have been undertaken on the response of woody perennials to this factor, especially with reference to such problems as the basis of winter hardiness, the natural distribution of plants, and their flowering and fruiting habits. A method has been developed for growing plants to maturity with artificial light as the only source of illumination, thus making possible the better control of all environmental conditions and thereby facilitating plant physiological research. Application of this process to a number of species shows that initiation of flowering and fruiting and other characteristic responses to differences in duration of the daily illumination period are brought about as readily with artificial illumination as with sunlight

Effects of different lengths of day upon the growth and reproduction of the corn plant have been studied. It has been found that the various types of corn react very differently and that such differences must be taken into account in acclimatizing corn and determining the adaptability of varieties.

### EFFECT OF BORAX ON FERTILIZERS.

Investigations of the effect of borax on different crops and in different quantities under a variety of soil conditions and climatic factors have been concluded. The results show that the injuries reported during the war were primarily due to the borax contained in the fertilizer in proportions exceeding 10 pounds per acre, although in many experiments much smaller quantities often caused some of the symptoms of borax poisoning to appear. Under moist soil conditions or rains following the application of the fertilizers the effect of the borax is much less than where dry conditions obtained. The potash sources which carried this borax into the fertilizers are now so purified that the quantity of borax contained in them is negligible. The elimination of borax from fertilizers to a safe limit has been accomplished, and no further damage need be feared from this source.

## FOREST DISEASES.

### BLUE STAIN OF YELLOW PINE AND GUM.

"Blue stain," caused mainly by the fungus Ceratostomella, is the most important degrading factor in air-seasoned southern yellow pine and causes deterioration of many other kinds of lumber. In the South, the control of staining and molding fungi is perhaps the biggest problem in the industry. In air-seasoned pine and gum two-thirds of the stock becomes blued. Blued gum sells for $2.50 to $4 per thousand board feet less than "bright" stock, and exporters will not take stained stock at all. Anywhere in the country where lumber is cut, if the conditions of humidity and temperature are favorable, blue staining and molding will occur unless special preventive measures are taken.

### DECAY IN DOUGLAS FIR.

In the States of Oregon and Washington alone there is a stand of Douglas fir aggregating 505,000,000,000 feet board measure, which amounts to nearly one-fourth of the remaining stand of saw timber in the United States. Much of this is overmature, and the loss through decay in such stands is enormous. A loss of 20 per cent from decay in overmature stands is common, and in some cases the loss may reach 50 per cent or more, making profitable logging impossible. This large percentage of defect often leads to gross error in cruising timber and scaling logs.

It has been determined that all but a very small portion of the loss through decay is caused by the ring-scale fungus (*Trametes pini*). It has been found, contrary to the general belief among timbermen, that whenever this decay occurs in a living tree it is accompanied by outward visible indications of its presence. Applying this knowledge makes it possible to cruise timber and scale logs with much greater accuracy.

This study is now being carried forward to determine the age at which Douglas fir becomes subject to extensive decay. The determination of this age will enable stands to be cut before there is any appreciable loss and at the same time permit the trees to attain maximum size. Equally important is the periodic rate of increase in the loss through decay after this age has been passed. Such information will be of the highest value to the Government and to holding companies with extensive stands of mature or overmature timber, enabling them to estimate the loss in their holdings and to adapt their plans accordingly.

### CHESTNUT BLIGHT.

The southward spread of the chestnut blight has been steady, and data have been accumulated to answer the very numerous questions as to how much time it will take for the disease to reach a given locality, in order that owners of forest stands and the industries of that locality that are dependent on the chestnut may have time to readjust themselves. The experiments on breeding resistant and immune chestnuts continue, and search is being made for other resistant or immune chestnuts, both in the United States and in other countries. The most hopeful results obtained so far consist in the discovery of certain surviving resistant American chestnut trees, which are being propagated.

### WHITE-PINE BLISTER RUST.

White-pine blister rust is a destructive plant disease that reached America about 1900; it was introduced from Europe on infected white-pine nursery stock which was planted in many places in the eastern United States. The blister rust was first observed on currants at Geneva, N. Y., in 1906, and three years later was discovered on planted white pines. In 1913 it was found attacking native white pines, but its wide distribution was not suspected until the late fall of 1915, when the rust was discovered on currant and gooseberry bushes and white pines over a large area in Massachusetts and New Hampshire. Up to this time efforts had been made to stamp out the disease in pine plantations where it was known to be present. This policy was abandoned in the East when general scouting in 1916 showed that the disease was widespread on native host plants in the Northeastern States. As a result, experimental control work was begun in 1917 in cooperation with the affected States in the hope of developing practical methods of control which would assure the continued production of the white-pine crop.

Since then practical measures have been developed for the control of this disease under eastern conditions, consisting of the eradication of currant and gooseberry bushes within 900 feet of the pines. Control measures can be applied by pine owners at a cost sufficiently low to justify their general application, and any stand of white pine, large or small, can be adequately protected.

In the Eastern States there are more than 21,000,000,000 board feet of white pine, estimated to be worth $276,000,000, as well as a very large acreage of young growth. In many sections white pine is an important farm crop, providing a source of ready money, keeping the farmer's labor and teams busy during the winter, and giving him a profitable income from much of his land, which is suitable only for the growing of timber. White pine has been used extensively in reforestation and produces the most profitable forest crop that can be grown in the infected regions.

The development of practical control measures will not assure the continued production of white pine unless they are applied generally by pine owners within the next few years. To accomplish the general control of the disease, pine owners must be convinced of the danger from blister rust, must be instructed in the best methods of control, and persuaded to take immediate and concerted action to save their pine crops. Any pine owner can apply control measures, but to do effective work he must be able to identify the disease in its early stages and to recognize the different kinds of wild currants and gooseberries, as well as know the habits of growth and the best methods for finding and removing these bushes. The lack of this special knowledge on the part of the average pine owner, coupled with the deceptive nature of the disease, makes it difficult for him to realize the danger and the need for prompt action to protect the white-pine crop in infected regions. To meet this situation an intensive campaign of education and demonstration has been undertaken in cooperation with the Northeastern and Lake States that will bring to pine owners, through personal contact, the information and instruction they need to combat the blister rust adequately and prevent extensive damage to the white-pine crop.

The outstanding feature of the white-pine blister-rust situation during the past year was the discovery of this destructive disease in southwestern British Columbia and the Puget Sound region of Washington. This bureau, in cooperation with State and Canadian authorities, has taken prompt action to determine the extent of the infected area and, if possible, to control or eradicate this new outbreak of the disease. The age of infections found on pine trees proves that the disease was present in British Columbia in 1916, prior to the enactment of the Canadian blister-rust quarantine, and the rust has extended its range into the State of Washington.

The Federal quarantine (No. 26) which prohibits the movement of blister-rust host plants from States east of and including Minnesota, Iowa, Arkansas, and Louisiana and interstate to points west of the quarantine line has been continued, to prevent the introduction and spread of the disease in uninfected regions. In cooperation with the Federal Horticultural Board 70,180 shipments of nursery stock were examined for blister-rust host plants during the past year, and 135 shipments in violation of the quarantine were intercepted. These were returned to the consignor or destroyed by the consignee or State officials. The number of violations by nurserymen was reduced from 81 per cent in the spring of 1921 to 51 per cent in the spring of 1922. The increasing effectiveness of the quarantine is shown by this marked reduction in the number of violations by nurserymen. Practically all violations are found to result from neglect or carelessness, and this condition, when brought to the attention of nurserymen, has been corrected through improved business methods. In conducting this work cooperation has been given by the Post Office Department, common carriers, nurserymen, and State officials.

The appearance of the blister rust in the Northwest directly menaces seven different species of five-needled pine that are native to the Rocky Mountain and Pacific Coast States, all of which are susceptible to the white-pine blister rust. The present total merchantable stand of western white and sugar pine, the principal commercial species, is estimated at over 57,000,000,000 board feet, with a stumpage value of $228,400,000, about half of which is owned by the Federal Government. Even more important from the standpoint of future forest production are the 12,000,000 to 13,000,000 acres of second growth in which western white and sugar pine will form an important part of the timber crop.

## RUBBER.

### A HARDY RUBBER TREE FROM CHINA.

The need of developing home supplies of rubber is becoming recognized, in view of the danger of complete dependence on the remote East Indies for this essential raw material. It is known that several species of rubber-producing plants can be grown in the United States if practical methods of utilization can be devised. One of the hardiest species is the Chinese rubber-bark tree (*Eucommia ulmoides*), which produces a gum of potential value, with qualities somewhat intermediate between rubber and gutta-percha. This tree is deciduous and is not affected by low winter temperatures in the vicinity of Washington, D. C., though the flowers may be killed by late frosts, so that seed is not set every year. As the trees are of separate sexes and are wind pollinated the production of seed on isolated trees is not to be expected. Suppression of the terminal bud of each shoot is another peculiar and apparently normal habit of this tree and not an indication of frost injury, as might be inferred.

### UTILIZATION OF THE CENTRAL AMERICAN RUBBER TREE.

The Central American rubber tree (Castilla) is considered inferior to the Para rubber tree (Hevea) for purposes of commercial cultivation by methods employed in the East Indies, but Castilla may have a special value in developing rubber reserves in tropical America. Such reserves of rubber should be available in regions contiguous to the United States in case of emergencies that might interfere with communication or with the production of rubber in the East Indies. For emergency use Castilla would have an advantage in yielding its latex more readily and in the lower cost of collecting. Investigation is needed to improve the methods of extraction that might give the tree a better agricultural status. Study of the habits and distribution of different species of Castilla shows that they occupy a wide area in the lowlands of Central America and southern Mexico, including many districts that have very few people, so that the forests are left undisturbed and could be utilized as rubber reserves, either by planting or by preserving the natural forest growth of Castilla.

## SERVICE ACTIVITIES.

### CONGRESSIONAL SEED DISTRIBUTION.

During the fiscal year 1922 there were distributed on congressional and miscellaneous requests 11,198,385 packages of vegetable seed and 2,015,115 packages of flower seed, or a total of 13,213,500 packages, each containing five packets of different kinds of seed. There were also distributed 14,880 packages of lawn-grass seed and 11,444 packages of imported narcissus and tulip bulbs. These seeds were purchased on competitive bids, as heretofore. Each lot purchased was thoroughly tested for purity and viability before acceptance by the department, and tests of each lot of seed were conducted on the department's trial grounds to determine trueness to type.

The work of packeting, assembling, and mailing the vegetable and flower seed was done by a private contractor at the rate of $2.3535 a thousand packets, including the furnishing of the packets and envelopes.

### NEW AND RARE FIELD-SEED DISTRIBUTION.

A distribution of new and rare field seeds was made throughout the entire United States, having for its object the dissemination of seed of new and rare field crops, seed of improved strains of staple crops, and high-grade seed of crops new to sections where the data of the department indicate such crops to be of considerable promise. Each package contained sufficient seed for a satisfactory field trial, and the recipient was urged to use the seed, if feasible, for the production of stocks for future plantings. A report card and a circular giving full directions for the culture of the crop accompanied each package of seed.

Only seed of new crops or improved strains of standard crops were distributed. These included varieties of alfalfa, field beans, sweet clover, cowpeas, velvet beans, field peas, pasture and hay grasses for the South, millets, sorghums, and cotton. The outstanding results of the past year's distribution were accomplished through the distribution of new varieties of soy beans. The soy-bean oil industry, which is now being developed in the Corn Belt, has been materially assisted by the wide dissemination of improved varieties of soy beans through the agency of the department's new and rare seed distribution. The Victor cowpea, an improved variety developed by the department, is continuing to prove exceptionally promising, and it is believed that it will be very generally used in many parts of the South where cowpeas are largely grown.

During the year 101,000 packages of new and rare forage-crop seed and 96,000 packages of cotton seed, or a total of 197,000 packages, were distributed.

### SEED TESTING.

During the fiscal year 1922 the seed-testing laboratories of the bureau received and examined 29,671 samples of seeds. Of these, 17,100 came to the laboratory at Washington, D. C., and 12,571 to the five branch seed-testing laboratories maintained in cooperation with the State institutions. These samples represent both vegetable and field seeds from farmers, seed dealers, and investigators, to whom reports of analyses were sent, showing the presence of weed seeds and worthless material, or the germination, or both, as requested. Through this service the work of the seed-testing laboratories is immediately applied to practical agriculture. A total of 5,962 samples of vegetable seeds was purchased and tested for germination, and the results of these tests will be published. Some of these seeds (garden peas) were also field tested for trueness to name. Sweet-corn samples are being grown for field stands and observation as to the presence of disease.

## ENFORCEMENT OF THE SEED IMPORTATION ACT.

The total importations of forage-plant seeds subject to the seed importation act were 7,333,333⅓ pounds, or approximately 20 per cent greater than the previous year. Of all red clover imported 25 per cent was of Italian origin; 6,000,000 pounds less red clover and 2,000,000 pounds less crimson clover came in this year than last. This decrease was offset by increases of more than 6,000,000 pounds of alfalfa and 3,000,000 pounds of alsike-clover seed. Of orchard-grass seed 3,000,000 pounds were imported, against none during the previous year. White-clover, millet, rape, and rye-grass seed showed increased imports.

## DEMONSTRATIONS ON RECLAMATION PROJECTS.

Demonstration work has been conducted during the past fiscal year on 11 Federal reclamation projects, as follows: Minidoka, Idaho; Umatilla, Oreg.; Uncompahgre, Colo.; Huntley, Milk River, and Sun River, Mont.: Shoshone, Wyo.: North Platte, Nebr.-Wyo.; Bellefourche, S. Dak.; Newlands, Nev.; and Yuma, Ariz. Full-time men have had charge of the work on the Minidoka, North Platte, Uncompahgre, Newlands, and Shoshone projects, while on the others, owing to limited funds, part-time men only could be placed, to handle special problems needing attention.

With the exception of the irrigation work conducted on the Milk River and Sun River projects in Montana and the Umatilla project in Oregon, the field men have confined themselves almost entirely to the development of the live-stock industries. The reason for placing so much emphasis on live stock is that crop disposal is one of the big problems confronting project farmers. Their long distance from the large consuming centers, coupled with excessive freight rates, makes unprofitable the shipment of bulky products, such as forage crops. The greater part of the land on most of the projects is devoted to forage crops and pasture. Representatives of this bureau have endeavored to impress upon the farmers the need of keeping sufficient live stock on their farms to enable them to dispose of their forage crops profitably.

# REPORT OF THE FORESTER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
*Washington, D. C., September 30, 1922.*

SIR: I have the honor to transmit herewith a report of the work in the Forest Service for the fiscal year ended June 30, 1922.

WILLIAM B. GREELEY,
*Forester.*

Hon. HENRY C. WALLACE,
*Secretary of Agriculture.*

## NATIONAL FORESTRY POLICY.

Every year makes the forest problem of the United States more clear. Its main features are:

1. The rising cost of timber products due primarily to heavier transportation charges from more and more distant sources of supply.
2. The unproductive condition of immense areas of land which are not adapted to agriculture.

The cut of lumber is decreasing in all the Eastern States; in practically every State west of the Great Plains it is increasing. The large sawmills of the country are in full migration westward to the last great virgin timber supply on the Pacific coast. During the past 30 years the pineries of the South have been the mainstay of the densely populated Central and Eastern States for the softwood lumber used in building, in general construction, and in many manufactures. Their cut is dwindling. Every year scores of sawmills are dismantled. The rapid increase in lumber shipments through the Panama Canal foreshadows the time, in the near future, when the principal source of softwood lumber for the entire Nation will have shifted to the west coast and the average freight cost paid by the home builder or manufacturer will have advanced to a new and higher level.

When the coniferous virgin timber of the far West is exhausted in its turn, if the principal source of supply shifts to Siberia or South America the transportation conditions which control the present lumber market will become different only in degree. Further, as the sources of supply become more restricted and more distant from the principal centers of consumption, opportunities for competition are lessened; and temporary shortages due to bad seasons, labor troubles, or congestion of transportation facilities are more probable and more severe. Thus the conditions of the trade become more favorable to monopolistic control, to violent market fluctuations, and to high prices. And we are dealing with a basic raw material, as widely used and as necessary to national existence as coal.

The accessible timber of the world is inadequate to the requirements of modern civilization. We now draw one-third of our paper from Canada. The northeastern paper mills have already been seriously handicapped by the embargo against the export of pulpwood cut on crown lands, which form a large part of the Canadian forests. There is likelihood that this embargo will be extended to all forest lands in the Dominion, completely shutting off raw wood from Canada as a source of supply for the paper industry of the United States. This illustrates the hazard of becoming dependent upon foreign supplies of timber.

The problem of unproductive land left in the wake of the sawmills or abandoned by the farmer has assumed enormous proportions. Our merchantable timber is being cut at the rate of four or five million acres annually, and enormous areas of logged-off land have accumulated which are not fit for cultivation but on which little or no new timber is being grown. The extent to which these millions of acres of idle land have been swelled by the ebbing tide of cultivation in many States is not generally realized. Between the census years of 1910 and 1920 the total area of improved farm land increased 6 per cent, due to agricultural expansion in the South and West and to the stimulus of war-time demands for crop production; but in 18 of the Eastern and East Central States the improved farm land shrank at the rate of 800,000 acres a year. New England lost 32,000 farms, with a net decrease during the 10 years of over a million acres of improved land. There can be no question as to the steady contracting of cultivation in a considerable number of the oldest and most populous States and the consequent lapse of large areas of land into partial or complete idleness. What to do with unused and unproductive land is one of the most fundamental economic and social problems of the United States.

Including burned and cut-over areas and abandoned fields which once grew timber, one-third of the soil of the Union is forest land. And three-fourths of it lies in the Mississippi Valley and eastward to the Atlantic coast, in the very States having the densest population and the largest consumption of timber products. Over 40 per cent of New York and Pennsylvania is forest land. Seventy-five per cent of Maine and of New Hampshire is forest land. From 45 to 70 per cent of the area of each of the South Atlantic and Gulf States is forest land. The use of these vast areas of nontillable land for growing successive crops of timber would kill two birds with one stone. It would insure ultimately a supply of forest products adequate for all national requirements; and it would go far toward maintaining a virile rural population and stable rural communities in the regions of inferior soil and limited agriculture.

The working out of a vast economic problem of this character will necessarily require a long time and can be only partially accomplished or influenced by public action. Steady progress is being made from year to year in the protection of forest lands from fire, particularly through increased State and Federal appropriations, the encouragement given to private protective effort by public cooperation, and the enactment of better State laws for reducing the hazard caused by logging débris. Nation-wide fire protection was given a strong impetus during the past year by a threefold increase in the appropriation for Federal cooperation with the States in protecting the forested watersheds of navigable streams. This appropriation is expendable only in States which at least match the Federal funds, and has been the cause, since its initiation in 1911, of a constantly widening circle of forest protection through public and private cooperation. But while ground is being gained and held, it must be recognized squarely that our national task of forest protection is still less than half performed and that the recurrent burning of forest lands remains the greatest handicap upon general reforestation.

Undoubtedly the second greatest drawback upon timber growing in the United States is the deterrent effect of the property tax levied year after year upon land bearing young trees. One of the outstanding needs of the situation is a system of taxing growing forests under which the principal burden will fall at the time of harvesting the matured crop but which is so adjusted as to be equitable to other classes of taxpayers and to meet the needs for public revenue. Earnest efforts to devise an adequate plan for taxing forest lands are now being made in at least a dozen States; and the Forest Service is engaged in a nation-wide study of the subject with the purpose of aiding local agencies and promoting a sound public conception of the problem.

A survey of lands, forests, waters, and wild life in northern Michigan has been undertaken by the State with a view to ascertaining the exact situation as to soil conditions, forest and game resources, denuded and unproductive land, agricultural and timber-growing possibilities, and opportunities for recreational development. This survey will afford the basis of a comprehensive State policy for dealing with its natural resources. It is an example of what should be done in every one of the 39 States which contain important areas of forest land.

There have been many other recent indications of public interest and effort in response to the clearer conception of the situation as to timber shortage and idle land. Movements are in progress to secure forestry laws in Florida, Georgia, Mississippi, and Missouri, and to extend and strengthen legislation favorable to reforestation in many other States. The creation of additional State forests is receiving a strong impetus in Texas, Minnesota, and California, while in New England the establishment of town forests is gaining noticeable headway. Meanwhile the pressure of purely economic forces is having a gradually more marked effect in stimulating the growing of timber crops, particularly in the Northern and Eastern States. The commercial planting of forest trees is increasing from year to year. Thousands of farmers and other small owners are more or less systematically reforesting their inferior lands. A considerable number of far-sighted companies engaged in the manufacture of timber products or in other industries which require wood have embarked upon the reforestation of their lands upon an extensive and well-planned scale.

These facts illustrate the many angles of the forest problem and the many factors which will contribute to its ultimate solution. We are still far short of a balance between timber use and timber growth, and the inroads upon the remaining supply of stumpage will doubtless be accelerated as building and industrial activity assume more normal proportions. Yet real progress is being made in the amount of young forest growth in the United States, which will ultimately contribute to the timber supply.

In the specific work of the Forest Service bearing upon the national situation, the most striking advances during the past year were the threefold expansion of forest protection in cooperation with the States and the enactment of a general forest exchange law. This legislation will make possible a substantial consolidation of the existing national forests and their ultimate extension through the inclusion of private cut-over lands within their exterior boundaries. A significant step was recorded in the acquisition of additional national forests under the act of 1911 through the approval of the purchase of 74,000 acres in western Pennsylvania, on the Ohio watershed, which will form a nucleus for the Allegheny National Forest. The service is continuing the nation-wide study, in cooperation with State foresters, timberland owners, and other agencies, of the barriers to reforestation which exist in each important forest region, and of the methods of cutting and fire protection which are necessary to keep the various types of forest land productive. One of the results of this investigation will be to formulate in as definite terms as practicable the measures which may equitably be enforced by public regulation in each region to keep up the productivity and usefulness of its forest lands.

During January, 1922, extended hearings were held by the Committee on Agriculture of the House of Representatives on the need for additional Federal legislation dealing with the national forestry situation. It is earnestly to be hoped that a constructive measure will be brought before Congress as the result of these hearings. It is urgent that aggressive national leadership be exerted in meeting what is steadily assuming the proportions of a grave national menace. Our national policy of forest conservation has been a matter of slow but sustained growth for over 30 years. It is not to be expected that its remaining chapters can all be written at once, and particularly that the extent and manner of exercising public control over private forest lands and industries can be settled in any final way until public sentiment shall have been more definitely and maturely formed on this subject. But there can be no question as to the wisdom or urgency of immediate legislative action on certain fundamental steps in any adequate Federal program of reforestation.

The immediate needs are:

1. The extension of Federal cooperation with States in forest protection on a scale commensurate with the national interests at stake and with a broader legislative basis adapted to the practical requirements of the situation. Such cooperation should not be restricted to the watersheds of navigable streams and should be contingent upon compliance by the cooperating States with standards established by the Secretary of Agriculture.

2. An enlarged scale of national forest purchases under the act of March 1, 1911, in order that the benefits of Federal forest ownership may be more widely applied in critical, or "key," areas.

3. The extension of forest protection and management to all lands now under national ownership or control whose greatest utility lies in the growing of timber or protection of watersheds. This should include not only the forested lands still in the unreserved public domain, but also those within military or naval reservations, recognizing the prior service of lands of the latter class for national-defense purposes.

4. Cooperation with the States in growing and distributing forest planting material, in order that this important means of reforestation may be more widely employed.

5. Provision for enlarged research in the growing and use of timber. The investigative agencies of the country are now unable to keep pace with the demands of timber growers and timber-using industries for the technical information needed to direct soundly their undertakings. The availability of accurate scientific data underlies every effort for the conservation of existing timber supplies and the growing of new timber crops.

## FORESTRY IN ALASKA.

Good progress was made during the year in collecting the information essential to the practicable development of the Tongass National Forest, which occupies most of the heavily timbered panhandle of Alaska. The merchantable timber on this forest includes at least 100,000,000 cords of western hemlock and Sitka spruce. Fully 90 per cent of this timber is admirably adapted for use in the manufacture of wood pulp and paper. It is estimated that this forest alone can furnish perpetually an annual yield of print paper equal to one-third our total national consumption.

As a step toward the establishment of the industry the Tongass National Forest was last year tentatively divided into 14 zones, each embracing sufficient timber to furnish a large paper mill with a permanent supply of raw material. The lines of each zone have been so drawn as to include water powers sufficient to meet the requirements of manufacture. In the further development of this plan, the service has had two crews in the field, one estimating and appraising the timber in each zone, while the other, headed by a hydroelectric engineer, has been examining and surveying water-power resources and preparing maps and reports covering each power site in detail. The Federal Power Commission is cooperating with the Forest Service in securing the water-power data. This work is not only providing reliable information regarding the water power available for a local paper industry but also has resulted in the discovery of a number of valuable water-power sites not heretofore known to exist, notably one permitting the development of from 22,000 to 24,000 horsepower at a very low cost.

Economic conditions during the past year have not been favorable to the launching of a pulp and paper industry in Alaska. Business in the Territory has encountered the same difficulties as in the States. The drop in the market price of wood pulp last year resulted in the temporary closure of the one pulp mill in Alaska. Ocean freight rates are an important factor in marketing such a bulky product, but it appears probable that the local industry will be more successful if it includes the manufacture of pulp into paper. Evidently this belief is shared by a number of responsible concerns which have submitted applications for the purchase of pulpwood from the Alaska National Forests and applications for water-power licenses for the purpose of manufacturing both pulp and paper. As soon as they are satisfied that business conditions are stabilized, including a stable labor and money market, it is reasonable to expect the extension of this important industry to southern Alaska. Best of all, the industry when established will be upon a permanent basis, each mill being assured a perpetual local supply of raw material at a reasonable price. The national forest contract offered is entirely acceptable to experienced paper manufacturers, who have no fault to find with the terms of sale established by the Government.

Meanwhile 86 per cent of the lumber used in Alaska is cut from the Government forests, and Sitka spruce from the Tongass National Forest is finding an outlet in the markets of the world. The sawmill at Wrangell during the past summer made a shipment of 45,000 feet board measure of Sitka spruce for the London market, and another lot of 450,000 feet board measure was shipped from Wrangell through Prince Rupert to eastern points. During the latter part of August and September a 5-masted schooner was loaded at Ketchikan, Alaska, with a cargo of approximately 1,800,000 feet of spruce for the Australian market and 3,000,000 feet more will be shipped in December from the same mill. This lumber was all cut and manufactured locally from timber purchased from the Tongass National Forest. Thus the industries developed by this great national forest are making a place for Alaska timber in the general lumber markets, furnishing labor to the residents of Alaska, and bringing outside capital into our northern ports.

The roads which are being constructed in the national forests in cooperation with the Bureau of Public Roads are proving a great factor in improving business and living conditions in southeastern Alaska. During the past a number of roads were extended out from the chief towns in the forest. The result in travel and in business and home development has been amazing. In some cases the road has been scarcely completed before every foot of frontage on each side of the highway has been taken up in suburban lots and neat and comfortable homes have been erected. Communities are being literally transformed in this way and their desirability for year-long residence greatly increased. The result is a more contented and permanent local population.

That the policies and activities of the Department of Agriculture have won the approval and support of the people living in and near the Alaska forests is becoming every day more evident. The encouragement and assistance given in building up an export lumber trade, the basic work going forward for the establishment of the pulp and paper industry, and the large expenditures which are being made on forest roads, together with a decentralized local administration, are contributing largely to the growth and prosperity of the Territory.

It is becoming evident that the solution of the Alaska problem is local self-government. The people of the Territory who come in contact with the national forests are thoroughly satisfied with the existing form of administration and control of these properties. Their criticisms of Federal red tape are not usually directed against the bureaus of this department. The counsel and assistance of our scientific bureaus are welcomed. Apparently what the people of Alaska want is not the power to run the Government's business or property in Alaska but power to run their own business. They do not object to the two national forests in Alaska being administered just as national forests are administered elsewhere, but they want to make their own laws, levy their own taxes, and spend their own public money just as do the people in the States. In short, what

Alaska wants is not that the Union should be ousted from the Territory, but that Alaska should be admitted to the Union.

It seems to be generally accepted that the Territory as a whole is not ready for statehood, but unquestionably that part lying east of the one hundred and fifty-second meridian and south of the Arctic Circle has the economic wealth and the stable, law-abiding population which according to our historic policies and precedents have always been recognized by Congress as entitling continental territory and people to self-government in the Union. From the standpoint of national-forest administration and development, no happier step could be taken than admittance of this part of the Territory to the full rights of an American Commonwealth.

## THE PERSONNEL OF THE FOREST SERVICE.

The national forests comprise nearly 157,000,000 acres of land in the most rugged and isolated parts of 26 States. The forest ranger manages an average unit of 155,000 acres, and the forest supervisor an average unit of 1,060,000 acres. The type of country in which these men work varies from the flat pineries of Florida to the roughest and most inaccessible mountain ranges of Idaho or the rugged coast of southern Alaska. The nature of their duties varies from putting out fires and building trails in vast, unbroken, and undeveloped stretches of virgin forest to serving the multifarious needs of urban and industrial centers on national forests adjacent to them.

The clientele of the national forests is as varied as their resources and topography. In some ranger districts the principal concern is the selling and cutting of timber where the demand exceeds the supply and the rate and methods of cutting must be closely controlled. In others present users are chiefly stockmen and the immediate problems are the allotment and efficient use of pasturage. On still other districts the demands of the recreation-seeking public necessarily claim a large share of the forest officers' time and thought. The nine hundred-odd ranger districts in the national forests present almost every conceivable variation in the nature of the resources and the kinds of public needs.

The field officers of the Forest Service must do much of their work apart and alone. The very barriers of distance shut it off from close superintendence or "checking up." The duties of forest supervisors and rangers can not be standardized and directed like those of a group of factory employees. Their districts can not be run by rules out of a book, or through the time-worn procedure of "report and recommendations" to some desk official a hundred or a thousand miles away. They must deal with a bad forest fire or supply the wants of an isolated settler or act upon the request of a logging company or meet any one of a dozen unforeseen contingencies as responsible agents of the Government, qualified and authorized to act on the spot.

The administration of the national forests is one of the most searching tests ever undertaken in public ownership and management of natural resources. Red tape and long-range administration would be fatal. Reliance must rather be placed upon the initiative and self-directed efforts of loyal and capable men to whom specific units are entrusted for administration in accordance with general policies and who are held to responsibility for good performance by competent inspection. Local responsibility in well-trained hands is the key to success in conserving the resources of the national forests and making them of the maximum public service.

The most important task in national-forest administration is to build up a field personnel which is qualified by the mastery of their jobs and by their training in responsibility to act with dispatch and efficiency on the ground. The demands of the public upon the national forests are constantly expanding, both in volume and variety. The capacity of the field organization of the Forest Service must keep pace with the size and scope of its job. This is partly a matter of legislation and appropriations. More largely, however, it is a matter of selecting and training field personnel and of bringing out and utilizing the best which men have in them, under the driving power of responsibility.

One of the major efforts of the service is to put into full effect a plan of personnel management which will accomplish these results. Its chief features are:

1. The careful selection and systematic training of forest guards, the temporary summer force from which qualified rangers can largely be recruited. As far as practicable the guards selected for summer work on each national forest are given at least three days of intensive training, under experienced rangers, in the technique of forest-fire detection and suppression.

2. Raising the qualifications of permanent rangers in education and experience and bettering such qualifications, after men enter the permanent ranks of the service, by every possible form of training in the duties to be performed. This includes winter correspondence courses in such subjects as forestry, range management, fire protection, and national-forest aims and policies, together with group conferences of rangers and supervisors, and training camps for the intensive instruction of limited numbers of men under the best experts in the service.

3. Increasing the force of technically trained foresters and grazing experts to the fullest extent consistent with other financial demands.

4. Requiring each ranger and forest supervisor to plan his work ahead, each year, with a view to economy in the use of time and its expenditure upon the most important tasks in sight. The annual work plan for each administrative unit can not be an inflexible or cut-and-dried affair, conforming to uniform and prescribed rules. It is a weighing and listing of the jobs to be put through each season, in the order of their urgency, by the officer immediately responsible for getting them done, with the guidance and oversight of his superior. Each work plan covers the specific tasks of a specific administrative unit and group of men. No two of them are alike. Each must be adapted to the needs of the local situation. Each must determine the standards of performance in individual duties or undertakings which may be justified in meeting the needs and putting through the work of the unit as a whole. Left largely to their own initiative and responsibility, as our field officers must be, and confronted with more to be done than can be accomplished, systematic planning of the use of time is the best guaranty that the efforts of the organization as a whole will be most fruitful.

5. Making clear to each field officer, grade by grade, the scope of his own responsibility and holding him personally accountable to his superior for making good. The stimulus of personal responsibility with its call for individual resourcefulness and pride in results must

be the driving force. Closely centralized control or routine instructions would at best yield mediocre results. Forest officers must largely direct and organize their own work. They must stand or fall on accomplishment. To the extent that the service can by its policies and traditions make the sense of personal responsibility effective throughout the ranks of the organization, its aggregate capacity will be increased.

6. Directing and "holding up" the work of field officers as far as practicable by personal contact of superior with subordinates on the ground and by personal inspection and instruction on the jobs themselves. Field inspection of the constructive sort is infinitely more effective than paper supervision from a desk; and it is one of the most telling means of training and stimulating the local officers. The organization of the service with a view to more and better inspection is a necessary feature of good personnel management.

It rests primarily with the service itself to build up the quality and capacity of its field personnel along these lines. That task has been aggressively undertaken. But at three points we are dependent in large measure upon action by Congress. The first is financial provision for the training of forest rangers in field instruction camps. The training of these officers must now be carried on by hook or by crook, through incidental means and expedients which fall far short of the mark. Provision should be made for a six or eight weeks' training camp in at least four of the field districts, where every year 30 to 40 rangers can be given expert instruction with special emphasis upon fire detection and suppression. Such training camps can not now be provided without sacrifices in the size of the protective force which are believed to be unwarranted.

A second financial need is to build up the numbers of technically trained experts in forestry and grazing. The service has been short in men of these qualifications ever since the war, whereas the volume of work requiring technical skill is constantly growing and the need of the service for new blood of this kind is greater than ever before. It is of the utmost importance that funds be provided for additional forest and grazing assistants who can be thrown directly into the expert management of timber and forage and who at the same time will develop within the organization the initiative and capacity for responsible assignments which are primary needs.

In the third place, the growth of the field organization and its adaptation to working conditions on the national forests are seriously handicapped by the arbitrary limitations of the statutory salary roll, on which a majority of the supervisors and rangers are carried. These limitations make it impossible to recognize exceptional efficiency, to allow for differences in responsibility and living costs under a wide range of assignments, and otherwise to adjust compensation to an organization of technical and executive workers. A statutory roll of salaries is wholly out of harmony with the character of the services rendered by the field officers on national forests and with the policy of Congress in dealing generally with employees of technical and administrative duties. A change from statutory to lump-sum provision in the case of all supervisors, deputy supervisors, and forest rangers would, without increasing the appropriations for the service, greatly aid our efforts to build up an organization of men capable of rendering a good account to the public.

## NATIONAL FOREST RECEIPTS AND EXPENDITURES.

The income-producing business on the national forests showed remarkable stability in view of the depressed or uncertain conditions in the timber and live-stock industries of the West, which afford the principal markets for national forest products. The abnormally low output of western sawmills which caused a decrease in receipts from timber sales for the preceding year continued until the last quarter of the fiscal year 1922; but for that quarter they exceeded $620,000 and for the entire year they totaled $1,780,347.24 and were almost identical with those of 1921. The receipts for the last quarter were far in excess of those for any preceding quarter in the administration of the national forests except one in 1920, and foreshadow a marked increase in the cut during the ensuing months.

Approximately 22 per cent of the cattle and 53 per cent of the sheep in the 11 Western States are grazed upon national forest ranges during part or all of the year. The grazing business of the forests consequently reflects closely the conditions in the live-stock industry of the West, which has been passing through one of the most severe financial depressions of its history. Many permittees have been forced to sacrifice portions of their breeding herds, and reductions on a few allotments were unavoidable to protect the range from deterioration. In consequence, the total number of stock grazed was about 10 per cent less than in the preceding year. The fees for this use of the national forest ranges will total, according to the best estimate now possible, $2,166,347, as against $2,415,618 for 1921.

The showing of receipts from grazing has been complicated (1) by legislation authorizing the postponement of payments for grazing permits issued during the fiscal year 1921, and (2) by the necessity, in view of the depression in the live-stock industry, of authorizing the payment of fees normally due during the fiscal year 1922 in two installments, the second of which will become payable in December of this year. The cash receipts during the fiscal year amounted to $2,933,930.07, but of this amount $1,948,925.09 represents deferred payments or collections for forage used during the preceding fiscal year. On July 1, 1922, there remained unpaid $77,997.40 in grazing fees due for the season of 1921 and approximately $100,000 due on the first installment for the season of 1922.

The actual receipts from all sources during the past year totaled $5,068,527.42. Grouping all minor uses and settlements under the major resources from which this income was derived, it may be distributed as follows:

| | |
|---|---|
| From the use of timber | $1,828,191.64 |
| From the use of forage | 2,962,971.60 |
| From the use of land, including water-power sites | 277,364.18 |
| Total | 5,068,527.42 |

Disregarding dates of payment and assuming that all outstanding obligations will be met by forest users, the income-producing business of the national forests aggregated $4,271,903, as compared with $4,468,940 during the fiscal year 1921.

The expenditures of the Forest Service during the fiscal year are shown in the following table by appropriation items. These do not include expenditures from the appropriations for forest roads, the purchase of forested lands on the watersheds of navigable streams, and cooperation with States in forest protection, which are covered elsewhere in this report.

*Expenditure of Forest Service appropriations.*

| | | |
|---|---|---|
| Protection and administration of the national forests | | $5,127,382 |
| Fighting fires which could not be suppressed by the regular protective force [1] | | 250,000 |
| Classification, survey, and segregation of agricultural land, and accomplishment of authorized land exchanges | | 75,000 |
| Planting 8,900 acres of nonproducing land, maintenance of nurseries, and experiments in tree planting | | 120,640 |
| Permanent improvements, such as buildings, bridges, trails, telephone lines, drift fences, and water improvements [2] | | 400,000 |
| Estimating the amount and fixing the minimum value of timber for sale | | 62,500 |
| Examination of intensively used ranges with a view to increasing their productivity by more scientific management of stock and forage | | 37,500 |
| Investigations: | | |
| (*a*) Forest products, including the forest products laboratory at Madison, Wis | $325,000 | |
| (*b*) Silvicultural | 85,000 | |
| (*c*) Range and forage plant | 35,000 | |
| | | 445,000 |
| Recording, digesting, and disseminating the results of scientific technical work | | 31,280 |
| Total | | 6,549,302 |

The total expenditures set forth above exceeded those of the preceding fiscal year by $328,480, or 5.3 per cent. Increased expenditures were made as shown below:

| | |
|---|---|
| For the protection and administration of the national forests, chiefly the employment of additional forest guards during the fire season | $183,740 |
| For estimates of timber and examinations of intensively used ranges | 20,000 |
| For investigations, particularly enlarged research in forest products and additional forest experiment stations | 136,740 |
| Total | 340,480 |

Expenditures for the classification of agricultural lands and consummation of land exchanges were reduced by $12,000.

## THE NATIONAL FOREST PROPERTIES.

At the close of the fiscal year the net area of national forest land was 156,837,282, acres, and the gross area (which includes interior holdings not in Government ownership) was 181,799,997 acres. The net area increased during the year 171,237 acres; the gross area decreased 20,462 acres.

Specific acts of Congress added to the forests 55,753 acres and a presidential proclamation 16,719 acres. In Michigan 11,499 acres passed from State to Federal ownership and were added to the Michigan National Forest by exchange. This was partly offset by a counter transfer to the same State of 8,320 acres, which was eliminated from the forest, and exchange agreements with other States resulted in transfers of title and eliminations totaling 43,675. Eliminations for town-site purposes (chiefly in Alaska) totaled 5,141 acres, and for other reasons 21,289. The gross area was further reduced by 34,328 acres through recomputations based on more complete data and new surveys.

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[1] An additional emergency appropriation of $341,000 was required for this purpose.

[2] Of this sum, nearly half is required for the maintenance of existing improvements used in the protection and administration of the national forests.

Exceptional opportunities were presented for extension of the eastern national forests through purchases under the Weeks law at prices much below the levels of earlier years. To the extent permitted by the available funds, full advantage of the situation was taken. Purchase agreements were approved by the National Forest Reservation Commission covering 242,169 acres at a total cost of $800,584.96. The average price of $3.30 per acre was the lowest in any single year since the initiation of purchases. Actual acquisition of the lands, however, through final transfer of title frequently does not take place until subsequent years. The acquisitions completed last year totaled 137,659.24 acres, with a cost of $839,406.91, or an average of $6.49 per acre. The location of the lands acquired is shown below:

| State. | Fiscal year 1922. | | Total acreage acquired to July 1, 1922. |
|---|---|---|---|
| | Acreage acquired. | Average cost per acre. | |
| Alabama | 16,135.62 | $4.62 | 63,262.25 |
| Arkansas | 16,673.85 | 4.03 | 40,050.61 |
| Georgia | 10,573.32 | 6.99 | 144,667.61 |
| Maine | 21.60 | 7.00 | 32,164.45 |
| New Hampshire | 21,096.66 | 7.88 | 404,207.10 |
| North Carolina | 21,405.03 | 9.31 | 323,110.82 |
| South Carolina | 0 | 0 | 18,454.26 |
| Tennessee | 31,826.33 | 5.15 | 245,250.12 |
| Virginia | 15,577.78 | 3.39 | 365,938.37 |
| West Virginia | 4,349.05 | 3.57 | 103,459.16 |
| Total | 137,659.24 | 6.49 | 1,740,564.75 |

The total cost of all lands purchased has been $9,329,426.80 and the average cost per acre $5.36.

The outstanding feature of the Weeks law work during the year was the formal establishment of the Allegheny purchase unit, embracing 440,000 acres on the upper headwaters of the North Fork of the Allegheny River in Pennsylvania. This unit constitutes the basis of what eventually will be another eastern national forest. Its establishment extends Federal activity in protecting the watersheds of the Ohio River drainage, and is a forward step in the promotion of reforestation and the consequent perpetuation of forest industries in northwestern Pennsylvania.

The new forest is situated at a point where problems both of watershed protection and of forest perpetuation reach a climax. Not far to the south lies Pittsburgh, whose serious flood losses have necessitated unprecedented flood-control measures, involving most elaborate and expensive engineering plans; and below Pittsburgh are other great cities whose losses of life and property due to floods have been sources of national concern. There is scarcely another region in the United States where the perpetuation of timber supplies is more important; for in a radius of 100 miles there are thousands of wood-using plants, representing investments of millions of dollars. The creation of this one 440,000-acre unit will not in itself materially reduce flood losses on the Ohio, nor perpetuate the enormous wood-using industries of the region, but it has exceptional importance because Federal participation in the solution of the two outstanding problems, in cooperation with the very effective work of the State itself, will eventually introduce new conditions of forest protection and management throughout the entire region.

The National Forest Reservation Commission, which controls all purchases of land under the Weeks law, has recommended that $2,000,000 be appropriated for the purchase of forest lands during the fiscal year 1924. This would be a return to the scale of expenditures established by the Weeks law itself for the first five years following its passage. With the field organization that effective work necessitates, and in view of the size of some of the forest holdings offered for purchase, $2,000,000 is the least that can be expended with complete efficiency. Its expenditure should add to the national forests 400,000 acres of forest land. Extension of the eastern national forests should not progress at any lesser rate. The original program outlined following the passage of the Weeks law is only about half completed. During the intervening 11 years the area of privately owned forest land in the United States subject to denudation, fire damage, and erosion, conditions the Weeks law was designed to remedy, has expanded enormously, despite the effective work instituted by some of the States. Outside of public domain reservations, there have been brought under public control and protection during this period, by all public agencies combined, a total of approximately 10,000,000 acres of forest land, while the total acreage cut over, and to some extent denuded by fire or damaged by erosion, has jumped from approximately 144,000,000 to 213,000,000 acres. It is essential that purchases by the Government more nearly keep pace with the progress of deforestation. A further reason for accelerating purchases is that the lands may now be bought on more favorable terms than can be expected in the future.

In last year's report special mention was made of the needs of the northern Ozark region of Missouri; the Berkshire Hills region of Massachusetts and Connecticut; the parts of Kentucky drained by the Cumberland and Kentucky Rivers; the Brown County section of Indiana; the Piedmont Plateau of Virginia, North Carolina, and South Carolina; and parts of Texas, Oklahoma, Michigan, Wisconsin, Alabama, West Virginia, Mississippi, and Maryland. The passage of another year and further studies only serve to emphasize more clearly the need for Federal ownership of key areas within such regions.

One of the most significant events in the history of the national forest movement occurred on March 20, 1922, when the President signed the bill authorizing the exchange of privately owned forest lands within any national forest for Government owned land or stumpage within any national forest in the same State. No other forest legislation passed in recent years will have so far-reaching an influence for the betterment and extension of the public forest properties. Under its terms, private owners who can not handle their holdings advantageously either independently of the national forests or under correlated use can offer them in exchange for lands or stumpage of equal value and better located for their purposes;

while the public can obtain lands suitable for permanent forestry without drain upon the Public Treasury.

There is no similarity between the forest exchange act of March 20, 1922, and the notorious lieu selection act of June 4, 1897. The latter conferred on owners of private lands within the national forest boundaries the right to surrender title to the Government and take other lands of equal area, without regard to wide discrepancies in value which almost invariably were grossly unfavorable to the public interest. Acceptance of the exchange by the Government was mandatory, not discretionary, so that there was no way to prevent lieu selections against the public interest. Because of these provisions, the act became an instrumentality of spoliation of public resources to such a degree that its repeal, on February 1, 1905, was a belated correction of a crying scandal. Under the act of March 20, 1922, the authority to make exchanges is vested jointly in the Secretary of Agriculture and the Secretary of the Interior, thus guaranteeing interdepartmental consideration of all proposals. There is absolutely no statutory obligation to approve or even consider exchanges disadvantageous to the public interest. Furthermore, all exchanges are based upon absolute, carefully determined equalities of value, area being purely of secondary consideration. Private acquisition of highly valuable public properties in exchange for lands of little or no market value thus becomes impossible.

The Forest Service, in administering the provisions of the general exchange act, has primarily in view building up the timber-growing resources of the national forests. Increased facility of administration and better protection from fire or other sources of damage are often valuable benefit but do not receive primary consideration. Under no circumstances are exchanges approved for the benefit or convenience of owners of private land, and a positive showing of clear-cut benefit to the public interest is required before any exchange is given serious consideration. The attitude of the Forest Service in approaching and in handling this exchange work has been one of great caution and conservatism. No effort has been made to inaugurate extensive exchanges under the act, but attention has been mainly given to a careful study of the situation on individual forests and to the preparation of detailed plans whereby the exchange work can be directed along the best lines.

The work of classifying the national forests under the act of March 10, 1912, has been completed except in the forests in Alaska, but areas upon which classification was suspended pending the removal of valuable timber resources or lesser areas where new developments in agriculture necessitate further consideration of the existing classification will require reexamination from time to time. A number of cases of the latter class were handled during the year, resulting in the listing and opening to entry of some additional areas of national forest land. Practically all lands of agricultural value the retention of which is not required in the public interest have been opened to entry. Further corrections in the classification will necessarily involve very small parcels of land, useful in most instances only in connection with adjoining lands in private ownership.

Almost all claims initiated under homestead laws other than the act of June 11, 1906, have now been patented or relinquished. The location of mineral claims under the mining laws continues uninterruptedly but the gradual elimination of many of the speculative features of mining has tended to confine mineral entries more strictly to lands of real mineral value. The substitution of prospecting permits and leases in connection with the development of coal, oil, gas, and phosphate has also had beneficial consequences.

## PROTECTION.

### PROTECTION OF THE NATIONAL FORESTS.

The fires on the national forests in the calendar year 1921 compared with those during the two previous years in number, size, and cause are as follows:

*Comparison of fires on national forests, calendar years 1919, 1920, and 1921.*

| Classes and causes of fires. | Number of fires. | | | Percentage of total. | | |
|---|---|---|---|---|---|---|
| | 1919 | 1920 | 1921 | 1919 | 1920 | 1921 |
| Class of fire: | | | | | | |
| Burns less than 0.25 acre | 2,839 | 3,122 | 2,947 | 41.75 | 51.37 | 50.37 |
| Burns between 0.25 acre and 10 acres | 2,014 | 1,724 | 1,606 | 29.62 | 28.36 | 27.45 |
| Burns 10 acres and over | 1,947 | 1,232 | 1,298 | 28.63 | 20.27 | 22.18 |
| Total | 6,800 | 6,078 | 5,851 | 100.00 | 100.00 | 100.00 |
| Causes of fires: | | | | | | |
| Railroads | 701 | 508 | 643 | 10.31 | 8.36 | 10.99 |
| Lightning | 2,197 | 3,082 | 1,451 | 32.31 | 50.71 | 24.80 |
| Incendiarism | 339 | 245 | 562 | 4.99 | 4.03 | 9.60 |
| Brush burning | 360 | 248 | 365 | 5.29 | 4.08 | 6.24 |
| Campers | 1,466 | 1,052 | 1,738 | 21.56 | 17.31 | 29.70 |
| Lumbering | 278 | 211 | 156 | 4.09 | 3.47 | 2.67 |
| Unknown | 1,155 | 485 | 674 | 16.98 | 7.98 | 11.52 |
| Miscellaneous | 304 | 247 | 262 | 4.47 | 4.06 | 4.48 |
| Total | 6,800 | 6,078 | 5,851 | 100.00 | 100.00 | 100.00 |

The area burned, damage sustained, and cost of fire fighting for the three years were as follows:

| Calendar year. | Total area of national forest land burned over (acres). | Total damage on national forest land burned over. | Total cost of fighting fires (exclusive of time of forest officers). |
|---|---|---|---|
| 1919 | 2,007,034 | $4,919,769 | $3,039,615 |
| 1920 | 342,193 | 419,897 | 911,483 |
| 1921 | 376,208 | 212,182 | 532,811 |

The 1921 fire season was extremely bad in district 3 (Arizona and New Mexico) owing to drought and high winds, and in the central Rocky Mountain and Eastern States it was the most dangerous season in many years. In the other districts it was less difficult than in 1920. District 1 (Montana and northern Idaho) had 1,336 fires, a decrease from 1920 of 380; there were 862 fewer lightning fires, but 482 more man-caused fires. District 6 (Washington and Oregon) had 1,311 fires, and district 5 (California) 1,196. Districts 1, 5, and 6 together had 66 per cent of all the fires, as against 73 per cent in 1920.

The total number of man-caused fires rose from 2,996 to 4,400, and was only 4 per cent less than in 1919, as against 35 per cent less in 1920. The marked increase in fires caused by campers, brush burning, and incendiarism is disturbing. The Forest Service has made every effort possible with its available funds to reduce the number of these unnecessary man-caused fires through educational and law-enforcement work. There is urgent need for additional preventive work, without which the task of protection is in danger of becoming steadily more difficult and costly.

The further reduction of damage and cost of fire fighting from the high mark of 1919 is due partly to the favorable season and partly to the continuous effort to increase the efficiency and numerical strength of the fire-control organization. Under the appropriations for the last fiscal year it was found possible to add 86 guards to the protection organization. This added strength played a part in the reduction of damage and fire fighting costs. The failure to show a smaller area burned than in 1920 is largely due to periods of severe hazard on certain of the eastern forests, where 139,603 acres were burned as against 63,471 in 1920.

The 1922 fire season is not yet over, so that no statistics covering it can be given; and most of it does not fall within the fiscal year covered by this report. It nevertheless requires some mention. In Oregon and Washington it has been the most severe in some years. The usual May and June rains failed, and fires set to clean up slash on private lands burned on into the danger period, with resulting great losses to property and growing timber. The National Forests have not suffered as severely as outside timber lands. The second year of special protection on the area of the great timber "blow down" in and near the Olympic National Forest in Washington has been as successful as was the first, and has cost the public Treasury less because the main improvements necessary are now installed. In view of the extraordinary peril of the situation and the difficulty of the task, this is a distinct achievement.

Outside of the Pacific Northwest the season has so far been somewhat more favorable than 1921, with the exception of a late period of hot "fire weather" and unusual hazard in California. There have been comparatively few lightning fires, and this has meant absence of the "bunching" of fires which has so often proved to be more than the protective force could handle.

Appropriations for the current year made it possible to add 100 men to the fire guard force for the 1922 season. This added force, coupled with the availability of road and trail crews for fire fighting in inaccessible regions, contributed measurably to the effectiveness of the protection given for this year. Nevertheless, the guard force is still inadequate, and provision for 100 additional guards has been included in the estimates for the fiscal year 1924.

### COOPERATION INCREASING.

Twenty years ago, in all but a few spots in the United States, forest fires were regarded with indifference if they did not threaten buildings or other valuable improvements; indeed, it was the custom in many regions deliberately to set fire to the woods for any of a number of reasons. The destructive effects of this attitude may be read in the barren sand wastes of the Lake States, the desolate areas of snags and brush where fires have destroyed the magnificent fir forests of the Northwest, the thinned stands and damaged timber of the pine forests in California, or the virgin forests of the Southwest which have no understory of young timber coming on to take the place of the mature trees as they are cut.

On many of the national forests settlers burned the slash in their clearings without concern lest their fires escape to the surrounding public domain. When such fires escaped, as they often did (and still do occasionally), they were not fought if they threatened merely to devastate publicly owned timberland. Fires were set to keep the woods free of undergrowth which hindered stock grazing and afforded a refuge to marauding animals. Regular burning was believed necessary to keep down ticks and other undesirable insects. Millions of acres were burned to make it easier for hunters to see and follow game, to enable prospectors to detect rock outcrops and small metalliferous deposits more easily, and in the belief that frequent burning increased the growth of forage.

Much educational work remains to be done both in the places where burning the woods is still believed in and to establish the habit of extreme care with fire on the part of the increasing throngs, particularly of nonresidents, who traverse or use the national forests. But a contrast of conditions as they were when the national forests were established and as they are to-day shows that much ground has been gained. There are now few spots on and adjacent to the national forests where local public opinion encourages the setting of fires. The characteristic thing is for farmers, miners, and others to volunteer posthaste when they see or hear of a fire on the national forests. They usually do not need to be called by the ranger.

In Colorado cooperation by permittees and residents on and near the forests has reached the point where settlers are willing to be responsible for the handling of fires on definite areas under view from their ranches or within striking distance. It has become the common thing for ranchers to go immediately to fires and stay as long as needed even when they have to drop haying or other urgent work at their homes. So reliable has this cooperation become that it has been possible to reduce the number of guards employed locally for fire patrol.

In the Trinity National Forest, in northern California, where from Indian days down to the creation of the national forests it had been the custom to "light burn" the forests, the settlers are still fearful that the dense growth of young timber which follows effective fire protection will interfere with their stock growing and mining industries, but they nevertheless cooperate effectively with the forest officers. For a period of several years when money for fire guards was lacking, in one ranger district of 225,000 acres all fire guards were dispensed with except the lookouts and one man at a central point to receive messages from lookouts and arrange over the telephone with settlers to take charge of the fires reported.

The increased cooperation with the Forest Service in California is shown by the following significant tabulation of the number of owners of private land intermingled with national forest holdings who have entered into cooperative agreements with the Forest

Service and paid their pro rata share of the cost of fire control in the ranger districts which include their lands:

| Calendar year. | Number of cooperators. |
|---|---|
| 1918 | 440 |
| 1919 | 493 |
| 1920 | 734 |
| 1921 | 927 |

In Oregon and Washington public opinion has forced the passage of State laws which require owners of private land to maintain adequate fire control, and cooperation is therefore complete in these States. Within the last 15 years all the larger timberland owners in Oregon, Washington, Idaho, and Montana have formed associations which work in the closest relations with the national forest fire control organization. Where private and national forest lands are intermingled either the Forest Service or the association takes over the whole job of protecting the area and the cost is distributed in proportion to the acreage of each owner. Railroads give varying degrees of cooperation but no longer leave their grant lands without systematic protection, and their efforts to keep fires from starting on the rights of way are steadily becoming more effective.

Fire control on the national forests becomes every year more effective because of the various forms of cooperation obtained. The trouble is that the best cooperation now rendered is not enough. The number of fires due to human agencies must be reduced from its present preposterous size if there is to be any assurance against catastrophic losses in the extremely hazardous fire years which weather cycles are sure to bring. The only way to accomplish this is to engrave the habit of care with fire deeply on the minds of users and visitors on national forests. There is no more reason for the usual man-caused fire on the national forests than there is for the usual grade-crossing accident. It is good business to carry on an educational campaign on the need for and the methods of effective care with fire in the woods.

### THE CONTROL OF INSECT INFESTATION.

The danger of serious losses by tree-killing insects and the necessity for prompt action to prevent these losses were forcibly brought out during the year by the situation in southern Oregon and northern California, briefly mentioned in last year's report. An epidemic of bark beetles in this region has caused a loss of valuable pine timber estimated at 1,500,000,000 board feet, worth at least $3,000,000, and endangered 10 times this quantity. The infestation was scattered over an area of 1,280,000 acres, of which about half is in private ownership, a small quantity in State ownership, and the rest owned or controlled by the Federal Government, partly in national forests, partly in Indian reservations, partly in the public domain, and partly in the revested Oregon and California railroad land grants. It was useless for any one owner to attempt to protect his land on account of the danger of reinfestation should the other holdings fail to be given simultaneous treatment. In recognition of this situation, Congress made available an emergency appropriation of $150,000 for control work on lands owned or controlled by the Federal Government, with provision that it should be spent only if satisfactory cooperation were secured from the owners of other lands in the infestation unit.

The result has been gratifying cooperation between the Department of the Interior, the State of Oregon, the owners of the private land, the Bureau of Entomology, and this service. The technical methods of combating the infestation were worked out by the Bureau of Entomology, which inspected and supervised their application by all of the administrative agencies which had charge of the actual work of felling the trees and killing the insects. Climatic conditions in the spring of 1922 were unfavorable and labor proved to be unexpectedly scarce. The control work, however, covered 69,710 acres, involving felling and peeling and burning the infested bark from 7,079 trees, containing 6,672,490 board feet of timber. About 180 men were employed. The total expenditure was approximately $42,000, of which less than $25,000 is chargeable against the special appropriation. The control work was well started and economically conducted, but must be continued for two or possibly three years longer. Reappropriation of the unexpended balance of the $150,000, which is now available only until December 31, 1922, is urgently needed.

Another insect infestation which has reached large proportions is on the Kaibab National Forest and the Grand Canyon National Park, in northern Arizona. Lack of funds prevented anything being done with this infestation until the spring of 1922, when at a serious sacrifice of other work about $8,000 was expended in an attempt to stop the epidemic, using technical methods recommended by the Bureau of Entomology. In this case work could be conducted later than in southern Oregon and was continued into the fiscal year 1923 in cooperation with the National Park Service, which furnished an additional $1,000 to enable treatment to be given to the portion of the infested area in the national park.

Insect infestations, like forest fires, spread without regard to land ownership. When, as in the case of the southern Oregon infestation, both public and private timber resources are endangered, it is obvious that the Government should be prepared to do its share, since the infestation must be treated as a whole. Furthermore, like forest fires, such epidemics should be treated in their initial stages in order to prevent at the least cost serious losses of valuable timber. The lack of funds for meeting these emergencies is comparable to a lack of funds with which to put out fires while they are small. The Bureau of Entomology has studied the life history of these tree-killing insects and is prepared to furnish advice as to how to hold them in check. It would obviously be desirable to have funds available with which the Secretary, using the knowledge of these experts, could act to protect the timber on any publicly owned forest lands, in cooperation with private owners, States, or other departments of the Federal Government if other than national forest lands are involved.

### COOPERATION WITH STATES IN FOREST PROTECTION.

The protection from fire of lands in State and private ownership on the forested watersheds of navigable streams, in cooperation with the States, was extended and made much more effective through the increase in the Federal appropriation from $125,000 to $400,000. The increase was used (1) to establish this cooperative work in two additional States, Ohio and Tennessee; (2) to increase the allotments to various States on the basis of the need of protection for their forests; and (3) to effect a better Federal organization, enabling more frequent and direct contact with State organizations and a closer inspection of the work.

The increased allotments made possible a much more effective organization of the work in many States, and in some instances led directly to the protection, even though often inadequate, of large areas previously without any effective fire-control organization. For example, it led to the extension of the protective activities to a forested area of 4,800,000 acres in the southern and southwestern parts of New York, and to 5,000,000 acres in Maine, which had previously received but slight protection. In Louisiana the additional Federal allotment and the increased State appropriation resulted in an enlargement of the protected area from 8,000,000 to 12,000,000 acres, and in Virginia protection was organized in four additional counties.

The steady growth of this cooperative effort and the meager proportion of the total expenditure borne by the Federal Government is indicated by the following table. It is noteworthy that the increase in Federal funds for 1922 was only about one-third of the increase in State expenditures, and that the area to which protection was extended increased 26,000,000 acres during the year.

*Cooperative expenditures for protecting forested watersheds of navigable streams from fire.*

| Fiscal year. | Federal appropriation. | Number of States cooperating. | Area protected (thousand acres). | Federal expenditure. | State expenditure. | Total expenditure. |
|---|---|---|---|---|---|---|
| 1911 and 1912 | [1] $200,000 | 11 | 61,000 | $53,287.53 | [2] $350,000.00 | $403,287.53 |
| 1913 | ............ | 12 | 68,000 | 53,247.82 | [2] 380,000.00 | 433,247.82 |
| 1914 | 75,000 | 17 | 83,000 | 79,708.27 | [2] 415,000.00 | 494,708.27 |
| 1915 | 100,000 | 18 | 95,000 | 69,581.75 | 505,924.70 | 575,506.45 |
| 1916 | 100,000 | 20 | 98,000 | 90,481.28 | 408,087.08 | 498,568.36 |
| 1917 | 100,000 | 21 | 103,000 | 90,580.14 | 435,328.11 | 525,908.25 |
| 1918 | 100,000 | 21 | 104,000 | 98,529.75 | 565,625.24 | 664,154.99 |
| 1919 | 100,000 | 22 | 110,000 | 99,921.38 | 625,445.54 | 725,366.92 |
| 1920 | 100,000 | 23 | 129,000 | 95,107.86 | 860,919.49 | 956,027.35 |
| 1921 | 125,000 | 24 | 140,000 | 119,529.83 | 1,066,027.47 | 1,185,557.30 |
| 1922 | 400,000 | 26 | 166,000 | 398,899.19 | [3] 1,896,920.43 | 2,295,819.62 |

[1] Available during period Mar. 1, 1911, to June 30, 1915.
[2] Approximate expenditure.
[3] Includes expenditures by towns and counties.

In addition to these public expenditures, the amounts now expended by private owners for the protection of their forests total approximately $1,000,000 a year. Private outlays for this purpose have been greatly stimulated by the cooperation offered by the Federal Government, and have at least trebled since this work was initiated in 1911.

The increased appropriation made it possible to aid in meeting emergency conditions in several States which had unusually severe fire seasons. Emergency allotments were made as follows: Maine, $17,600; Vermont, $1,000; Massachusetts, $1,100; Rhode Island, $500; Connecticut, $1,600; New York, $2,900; New Jersey, $1,400; Maryland, $200; and Washington, $1,400. The funds for these allotments were secured from unexpended balances in the allotments to States which had subnormal fire seasons during the summer of 1921, and by other economies. The total allotments to States, including these emergency allotments, were as follows:

*Cooperative expenditure in fire protection under the Weeks law, fiscal year 1922.*

| State. | Federal. | State. | Total. |
|---|---|---|---|
| Maine | $42,150.00 | $228,632.24 | $270,782.24 |
| New Hampshire | 8,787.08 | 45,526.21 | 54,313.29 |
| Vermont | 4,150.00 | 11,933.62 | 16,083.62 |
| Massachusetts | 11,450.00 | 67,316.11 | 78,766.11 |
| Rhode Island | 1,055.09 | 6,384.59 | 7,439.68 |
| Connecticut | 4,750.00 | 17,181.11 | 21,931.11 |
| New York | 26,892.84 | 163,371.19 | 190,264.03 |
| New Jersey | 7,950.00 | 34,831.57 | 42,781.57 |
| Pennsylvania | 27,500.00 | 512,190.56 | 539,690.56 |
| Maryland | 3,000.00 | 6,722.79 | 9,722.79 |
| Virginia | 16,786.55 | 16,786.55 | 33,573.10 |
| West Virginia | 6,655.58 | 9,186.19 | 15,841.77 |
| North Carolina | 9,506.91 | 9,506.92 | 19,013.83 |
| Tennessee | 10,381.58 | 11,566.84 | 21,948.42 |
| Louisiana | 12,600.00 | 39,771.88 | 52,371.88 |
| Texas | 10,500.00 | 14,004.35 | 24,504.35 |
| Ohio | 143.03 | 679.00 | 822.03 |
| Michigan | 25,000.00 | 140,367.48 | 165,367.48 |
| Wisconsin | 12,650.86 | 17,308.23 | 29,959.09 |
| Minnesota | 27,300.00 | 233,011.47 | 260,311.47 |
| South Dakota | 100.00 | 7,724.00 | 7,824.00 |
| Montana | 8,746.03 | 15,480.00 | 24,226.03 |
| Idaho, north | 16,800.00 | 39,985.95 | 56,785.95 |
| Idaho, south | 3,146.16 | 8,784.75 | 11,930.91 |
| Washington | 24,900.00 | 69,034.03 | 93,934.03 |
| Oregon | 27,455.38 | 107,649.63 | 135,105.01 |
| California | 22,749.98 | 61,983.17 | 84,733.15 |
| Administration and inspection | 25,792.12 | .............. | 25,792.12 |
| Total | 398,899.19 | 1,896,920.43 | 2,295,819.62 |

Unexpended balance, $1,100.81; appropriation, $400,000.

During the last six years the Forest Service has made an attempt to secure nation-wide information on the forest-fire situation. These data indicate that the number of forest fires averaged 33,500 annually. The area of forest land burned was 7,088,000 acres annually, and the immediate property loss was $16,424,000. The number of fires in 1921 was 38,400, which is more than the average, but the area of forest land burned in that year, 4,737,000 acres, was considerably under the average for the 6-year period, though the year was very dry and the fire hazard extreme in some portions of the country. It is significant that in the southeastern group of States—North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi, of which only North Carolina is organized for forest-fire protection—the area of forest land burned in 1921 was 58 per cent of the total in the United States, and the damage to timber was 49 per cent of the total damage in the country.

About half of the forest lands of the country outside of the national forests receive some form of systematic protection. Approximately 166,000,000 acres of privately owned forest land are wholly unprotected from fire, and on many other areas the protection is incomplete and inadequate. There is organized State effort in only 26 out of the 39 States which contain extensive forest areas. A yearly expenditure of $9,263,000 would fairly protect all of the privately owned forest lands in the United States. The combined efforts of the Federal Government, the States, and landowners to-day reach $3,327,000, little more than one-third of the amount needed.

With the present appropriation the Federal Government spends less than a quarter of the amount spent by the States on this fundamental phase of reforestation. It is doubtful whether any form of Federal expenditure is more valuable in assuring a future supply of forest products for the country than this cooperation, with its proven stimulus to increased efforts by States and by private owners. A material increase in the Federal appropriation for this purpose is urgently needed.

## NATIONAL FOREST MANAGEMENT.

### TIMBER.

The business depression in the lumber industry, noted in last year's report, passed its low point during the fiscal year, and a sharp recovery was in progress at its close. As a result the national forest timber receipts for the year were more than in 1921, and, although the cut for the entire year was smaller than in 1920, the cut for the last quarter of the year exceeded that of the corresponding period in 1920 by 25,000,000 board feet. The broad trend of the national forest timber business in distinction from periodic fluctuations due to temporary conditions is brought out by comparing the cut under sales at 5-year intervals—68,000,000 board feet in 1905, 380,000,000 in 1910, 566,000,000 in 1915, and 806,000,000 in 1920.

This increase is being accelerated by the migration of the lumber industry to the West, which is going on quietly but steadily. Since about 1900, when the cut in the Lake State pineries began to dwindle, the South has been the chief source of lumber for the greater portion of the country. Now this source of supply is failing rapidly, and production in the West is increasing. For the four years 1913–1916 the lumber cut in the South (including the North Carolina pine region) averaged over 18,425,000,000 board feet. For the four years 1917–1920 the average was 15,345,000,000 board feet, a shrinkage of more than 15 per cent. In the West, including the Rocky Mountain region, the average cut for the same periods rose from 8,826,000,000 to 10,522,000,000 board feet, or over 19 per cent. The westward trend of the industry is illustrated by the frequent opening of new mills in the West and by the recent public statement of an officer of one of the largest lumber-producing concerns of the country that it will practically cut out its southern timber in eight years.

This change in regional lumber production means that the timber on the national forests will come into increasing demand. The amount of timber put under contract of sale in the fiscal year 1921, mostly for future cutting, was over 2,100,000,000 board feet—more than in any previous fiscal year, in spite of the business depression. Instead of being undeveloped storage areas, the forests are being opened up by railroads or motor-truck highways and the grown timber put to use. This development must be carried out with foresight to insure the permanency of the use, through permanency of the resource. The cut must be regulated on the basis not only of knowledge as to how much merchantable timber there is and where it is, but also of knowledge as to the possible growth of timber; for on that growth depends the ability of the industries and wood users to get timber in the future. Definite plans for the control of the rate and place of cutting within logical economic and transportation units are being prepared on the national forests, in order that one of the primary purposes for their creation, "to furnish a continuous supply of timber for the use and necessities of citizens of the United States" (in the words of the basic act of June 4, 1897), may be accomplished. The plans necessitate a careful inventory of the forest and thorough study of its producing power. They are being prepared as fast as available funds will permit, taking first those forests and parts of forests where the call for timber is most pressing.

Meanwhile, applications for new large sales, involving the building of railroads and of new manufacturing plants, are creating demands which strain the resources of the service. The cruising and appraisal of the timber preparatory to sale and the administration of the sales will require more men and money at a rate commensurate with the increase in the business. It was only with great difficulty and at a sacrifice of other urgent work that, near the close of the fiscal year, a body of timber estimated to cut 890,000,000 board feet was cruised and appraised in Oregon in response to an urgent application. This timber is now being advertised, and if one or more bids are received its sale will result in building a new mill, which should be permanent, and a new railroad through an agricultural district adjacent to the forest. In another case, 235,000,000 board feet of timber was sold on the Snoqualmie National Forest in Washington. This timber, together with that on intermingled private lands, will form a 10-year supply for a new permanent mill. The largest sale made during the year was on the Lassen National Forest in California, where nearly a billion feet of timber was placed under a 30-year contract with a cooperative association of fruit growers. This sale and the plan for handling the timber on adjacent forest lands assure these fruit growers a permanent supply of lumber for boxes and other requirements.

It is not only lumber companies that secure timber from the national forests. Nearly 6,000 farmers get it each year at the cost of administering the sales under the provisions of the act of August 10, 1912; fishermen on the coast of Alaska buy fish-trap piling and timbers; the coal mining companies, and the copper producers in Montana, Wyoming, Colorado, New Mexico, and other States buy mine timbers; railroads are supplied with ties, and telephone, telegraph, and power companies with poles; pulp and paper mills get pulpwood; the turpentine distiller buys the right to tap carefully certain kinds of trees for the pitch or "gum" from which turpentine and rosin are produced. Manufacturers of furniture, excelsior, barrels, toothpicks, tennis rackets, crutches, shoe pegs, violins, tannic acid, charcoal, and many other things look to the forests as sources of raw material; even the medicine manufacturers draw on the forests, for they obtain there several thousand pounds of cascara bark a year. Only by careful, consistent management in accordance with well thought out plans can these demands continue to be met indefinitely through having timber grow as fast as it is cut.

As pointed out last year, the opportunity for developing permanent instead of short-lived wood-using industries is especially good in

Alaska, where the cruising of timber and the study of water powers, in anticipation of the certain establishment of a large pulp and paper industry, were continued. One result of this work was the discovery of new valuable water powers available to tidewater.

*Timber sold, calendar year ended December 31, 1921.*

| State. | Board feet. | | | Value. | | |
|---|---|---|---|---|---|---|
| | Commercial sales. | Cost sales. | Total. | Commercial sales. | Cost sales. | Total. |
| Alabama | 21,000 | | 21,000 | $106 | | $106 |
| Alaska | 11,955,000 | | 11,955,000 | 17,477 | | 17,477 |
| Arizona | 8,519,000 | 647,000 | 9,166,000 | 15,524 | $626 | 16,150 |
| Arkansas | 4,642,000 | 301,000 | 4,943,000 | 21,776 | 304 | 22,080 |
| California | 732,914,000 | 2,194,000 | 735,108,000 | 2,238,732 | 1,220 | 2,239,952 |
| Colorado | 19,904,000 | 1,239,000 | 21,143,000 | 54,909 | 1,207 | 56,116 |
| Florida | 1,581,000 | | 1,581,000 | 5,986 | | 5,986 |
| Idaho | 117,126,000 | 5,166,000 | 122,292,000 | 415,686 | 4,658 | 420,344 |
| Michigan | | 12,000 | 12,000 | | 9 | 9 |
| Minnesota | 462,000 | | 462,000 | 4,485 | | 4,485 |
| Montana | 88,190,000 | 5,781,000 | 93,971,000 | 299,809 | 5,101 | 304,910 |
| Nevada | 1,675,000 | 194,000 | 1,869,000 | 2,077 | 158 | 2,235 |
| New Hampshire | 1,919,000 | | 1,919,000 | 15,176 | | 15,176 |
| New Mexico | 11,663,000 | 1,387,000 | 13,050,000 | 28,726 | 1,054 | 29,780 |
| North Carolina | 1,977,000 | | 1,977,000 | 5,948 | | 5,948 |
| Oregon | 137,114,000 | 2,757,000 | 139,871,000 | 383,789 | 1,719 | 385,508 |
| South Dakota | 7,144,000 | 882,000 | 8,026,000 | 19,100 | 805 | 19,905 |
| Tennessee | 2,974,000 | 172,000 | 3,146,000 | 4,871 | 172 | 5,043 |
| Utah | 16,659,000 | 1,389,000 | 18,048,000 | 59,051 | 1,299 | 60,350 |
| Virginia | 3,045,000 | 10,000 | 3,055,000 | 6,789 | 11 | 6,800 |
| Washington | 49,816,000 | 500,000 | 50,316,000 | 81,563 | 278 | 81,841 |
| West Virginia | 318,000 | | 318,000 | 1,324 | | 1,324 |
| Wyoming | 33,961,000 | 781,000 | 34,742,000 | 60,559 | 709 | 61,268 |
| Total, 1921 | 1,253,579,000 | 23,412,000 | 1,276,991,000 | 3,743,463 | 19,330 | [1] 3,762,793 |
| Total, fiscal year 1920 | 1,294,446,000 | 32,476,000 | 1,326,922,000 | 3,026,186 | 21,559 | [2] 3,047,745 |

[1] In addition, minor products not convertible into board feet were sold, value $5,485.
[2] In addition, minor products not convertible into board feet were sold, value $25,815.

*Timber cut under sales, calendar year ended December 31, 1921.*

| State. | Board feet. | | | Value. | | |
|---|---|---|---|---|---|---|
| | Commercial sales. | Cost sales. | Total. | Commercial sales. | Cost sales. | Total. |
| Alabama | 21,000 | | 21,000 | $106 | | $106 |
| Alaska | 14,316,000 | | 14,316,000 | 23,152 | | 23,152 |
| Arizona | 28,030,000 | 630,000 | 28,660,000 | 60,554 | $552 | 61,106 |
| Arkansas | 6,723,000 | 232,000 | 6,955,000 | 35,163 | 230 | 35,393 |
| California | 123,100,000 | 2,049,000 | 125,149,000 | 307,248 | 1,091 | 308,339 |
| Colorado | 34,411,000 | 1,463,000 | 35,874,000 | 86,469 | 1,245 | 87,714 |
| Florida | 1,017,000 | | 1,017,000 | 3,056 | | 3,056 |
| Idaho | 81,685,000 | 3,761,000 | 85,446,000 | 262,444 | 3,115 | 265,559 |
| Michigan | 271,000 | 12,000 | 283,000 | 601 | 9 | 610 |
| Minnesota | 6,939,000 | | 6,939,000 | 24,893 | | 24,893 |
| Montana | 37,933,000 | 5,643,000 | 43,576,000 | 88,369 | 4,726 | 93,095 |
| Nevada | 1,304,000 | 89,000 | 1,393,000 | 1,789 | 76 | 1,865 |
| New Hampshire | 3,341,000 | | 3,341,000 | 19,167 | | 19,167 |
| New Mexico | 23,337,000 | 1,477,000 | 24,814,000 | 45,961 | 1,013 | 46,974 |
| North Carolina | 10,230,000 | | 10,230,000 | 29,333 | | 29,333 |
| Oregon | 133,776,000 | 3,278,000 | 137,054,000 | 314,350 | 1,888 | 316,238 |
| South Dakota | 19,695,000 | 647,000 | 20,342,000 | 52,007 | 432 | 52,439 |
| Tennessee | 8,016,000 | 196,000 | 8,212,000 | 18,242 | 185 | 18,427 |
| Utah | 9,558,000 | 1,111,000 | 10,669,000 | 24,177 | 1,003 | 25,180 |
| Virginia | 4,778,000 | 26,000 | 4,804,000 | 14,624 | 24 | 14,648 |
| Washington | 77,573,000 | 529,000 | 78,102,000 | 135,406 | 303 | 135,709 |
| West Virginia | 231,000 | | 231,000 | 939 | | 939 |
| Wyoming | 39,906,000 | 588,000 | 40,494,000 | 98,767 | 471 | 99,238 |
| Total, 1921 | 666,191,000 | 21,731,000 | 687,922,000 | 1,646,817 | 16,363 | [1] 1,663,180 |
| Total, fiscal year 1920 | 783,947,000 | 22,184,000 | 806,131,000 | 1,754,599 | 15,800 | [2] 1,770,399 |

[1] In addition, minor products not convertible into board feet were cut, value $4,511.
[2] In addition, minor products not convertible into board feet were cut, value $10,381.

*Number of timber sales, classified according to amount of sale, calendar year ended December 31, 1921.*

| State. | $100 or under. | | | $101 to $500. | $501 to $1,000. | $1,001 to $5,000. | Over $5,000. | Total. |
|---|---|---|---|---|---|---|---|---|
| | Commercial. | Cost. | Total. | | | | | |
| Alabama | 6 | | 6 | | | | | 6 |
| Alaska | 155 | | 155 | 1 | 5 | 2 | | 163 |
| Arizona | 747 | 281 | 1,028 | 3 | 3 | 3 | | 1,037 |
| Arkansas | 30 | 115 | 145 | 4 | 1 | 3 | 1 | 154 |
| California | 615 | 404 | 1,019 | 17 | 5 | 16 | 4 | 1,061 |
| Colorado | 587 | 278 | 865 | 8 | 3 | 8 | 1 | 885 |
| Florida | 21 | | 21 | | 4 | 1 | | 26 |
| Idaho | 758 | 1,513 | 2,271 | 8 | 5 | 11 | 5 | 2,300 |
| Michigan | | 3 | 3 | | | | | 3 |
| Minnesota | 8 | | 8 | | | 3 | | 11 |
| Montana | 683 | 1,572 | 2,255 | 16 | 7 | 9 | 2 | 2,289 |
| Nebraska | 14 | | 14 | | | | | 14 |
| Nevada | 103 | 58 | 161 | | | | | 161 |
| New Hampshire | 111 | | 111 | 1 | | | 1 | 113 |
| New Mexico | 712 | 575 | 1,287 | 4 | 2 | 6 | | 1,299 |
| North Carolina | 160 | | 160 | 2 | | 1 | | 163 |
| Oklahoma | 31 | | 31 | | | | | 31 |
| Oregon | 313 | 543 | 856 | 6 | 3 | 3 | 5 | 873 |
| South Dakota | 379 | 189 | 568 | 4 | 3 | 3 | | 578 |
| Tennessee | 133 | 61 | 194 | 1 | | 1 | | 196 |
| Utah | 440 | 731 | 1,171 | 3 | 2 | 1 | 1 | 1,178 |
| Virginia | 325 | 9 | 334 | 3 | 1 | | | 338 |
| Washington | 285 | 106 | 391 | 6 | 3 | 10 | 4 | 414 |
| West Virginia | 17 | | 17 | | | | | 17 |
| Wyoming | 187 | 183 | 370 | 6 | 1 | 1 | 2 | 380 |
| Total, 1921 | 6,820 | 6,621 | 13,441 | 93 | 48 | 82 | 26 | 13,690 |
| Total, fiscal year 1920 | 7,182 | 5,580 | 12,762 | 141 | 84 | 174 | 111 | 13,272 |

## REFORESTATION.

The records of planting and sowing operations on the national forests are now kept by calendar years instead of by fiscal years, since when these operations are conducted at high altitudes the work is not infrequently in progress on June 30. The figures given in the following table, therefore, include some areas planted during the first six months of 1921 and reported last year with other figures for the fiscal year ending June 30, 1921:

*Planting and sowing on national forests by States, calendar year 1921.*

| State. | Area planted. | Area sown. | Total. | State. | Area planted. | Area sown. | Total. |
|---|---|---|---|---|---|---|---|
| | *Acres.* | *Acres.* | *Acres.* | | *Acres.* | *Acres.* | *Acres.* |
| Montana | 2,019.40 | | 2,019.40 | Wyoming | | 135.00 | 135.00 |
| Idaho | 1,776.00 | | 1,776.00 | Virginia | 61.67 | | 61.67 |
| Michigan | 1,461.80 | | 1,461.80 | Alabama | 8.00 | | 8.00 |
| Minnesota | 1,332.50 | | 1,332.50 | New Hampshire | 3.50 | | 3.50 |
| Colorado | 853.50 | | 853.50 | Arizona | 2.00 | | 2.00 |
| Nebraska | 431.25 | | 431.25 | | | | |
| Washington | 410.00 | | 410.00 | Total | 8,766.62 | 135.00 | 8,901.62 |
| Oregon | 407.00 | | 407.00 | | | | |

The decrease in the cost of labor and the completion of the readjustments in nursery activities caused by the smaller appropriations during the war resulted in a material increase in the area reforested; but until more funds are made available the work can be conducted on only an extremely small scale in comparison with the extent of the job. The total amount of land repeatedly burned over, chiefly before the creation of the forests, which can be restored to productivity only by planting is estimated at, at least, 1,500,000 acres. At the rate at which planting work is now being conducted, it will require between 150 and 200 years to reforest these denuded areas. The work is now largely concentrated in those regions where the greatest success is obtained, such as the productive pine regions of northern Idaho, western Montana, and the Lake States. Even in these regions, however, the scale of operations is necessarily small in comparison with the denuded acreage.

## RANGE.

### GENERAL CONDITIONS.

Except in Arizona and New Mexico and around the Custer National Forest in Montana, national forest range conditions were exceptionally favorable throughout the West during the grazing season of 1921. Heavy snowfall in the mountains the previous winter, an early spring, and copious rains extending into the early summer months produced a most plentiful supply of forage on the ranges and an abundant hay crop on the ranches. A prolonged drought held on in Arizona and New Mexico until well into the summer, but was finally relieved by heavy rainfall, and at the close of the 1921 season these ranges also were in excellent condition. The Custer National Forest in Montana suffered one of the most severe droughts ever known, which, together with a serious grasshopper infestation, caused a shortage of the beef crop and poor condition of breeding stock to begin the winter. Elsewhere the fall conditions were favorable and most of the stock remained on the forests for the full season.

The winter of 1921–22, however, was one of almost unprecedented severity and duration. The abundant hay crop of the preceding summer was entirely consumed, and many stockmen were compelled to turn their stock on the range in the spring in advance of forage growth. This was so late in starting that in the Northwest and Rocky Mountain region ranges normally in condition to use by the first of May were at the middle of June still snow-covered in many places, and with scant vegetation where the snow had gone. There were heavy losses of breeding stock, and especially of lambs. The loss of sheep was increased by the over age of breeding ewes, a result of depressed market and financial conditions which had prevented flock masters from selling their old ewes and replacing them with younger animals.

### USE OF THE RANGE.

The table on the following page shows the number of stock under permit for the calendar year 1921:

*Grazing permits issued and number of stock grazed, calendar year 1921.*

| State. | Cattle, horses, and swine. | | | | Sheep and goats. | | |
|---|---|---|---|---|---|---|---|
| | Permits issued. | Number of stock grazed. | | | Permits issued. | Number of stock grazed. | |
| | | Cattle. | Horses. | Swine. | | Sheep. | Goats. |
| Alabama | 9 | 190 | 4 | ........ | ........ | ........ | ........ |
| Arizona | 1,482 | 360,038 | 4,306 | 492 | 140 | 316,447 | 4,030 |
| Arkansas | 203 | 3,304 | 25 | 124 | 5 | 12 | 167 |
| California | 2,856 | 205,132 | 6,363 | 1,052 | 517 | 557,125 | 10,691 |
| Colorado | 4,344 | 344,303 | 8,133 | 27 | 734 | 909,767 | 1,316 |
| Florida | 43 | 866 | 3 | 60 | 3 | 659 | 21 |
| Georgia[1] | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Idaho | 3,863 | 162,277 | 11,801 | ........ | 885 | 1,374,836 | ........ |
| Montana | 2,871 | 157,468 | 13,599 | ........ | 468 | 670,751 | 110 |
| Nebraska | 41 | 6,143 | 521 | ........ | ........ | ........ | ........ |
| Nevada | 499 | 71,807 | 3,490 | ........ | 132 | 341,947 | ........ |
| New Hampshire | 16 | 166 | 19 | ........ | ........ | ........ | ........ |
| New Mexico | 1,914 | 165,862 | 3,411 | 377 | 563 | 390,675 | 27,143 |
| North Carolina | 341 | 1,939 | 83 | 137 | 24 | 309 | ........ |
| Oklahoma | 66 | 3,919 | 266 | ........ | ........ | ........ | ........ |
| Oregon | 2,230 | 154,880 | 8,567 | 21 | 519 | 727,176 | 96 |
| South Dakota | 781 | 33,712 | 2,596 | ........ | 4 | 4,200 | ........ |
| Tennessee | 111 | 873 | 24 | ........ | 7 | 136 | ........ |
| Utah | 6,963 | 161,518 | 8,139 | 162 | 1,725 | 766,337 | ........ |
| Virginia | 271 | 2,781 | 6 | ........ | 5 | 196 | ........ |
| Washington | 918 | 27,470 | 2,396 | ........ | 150 | 193,891 | ........ |
| West Virginia | 8 | 44 | ........ | 1 | 1 | 18 | ........ |
| Wyoming | 1,197 | 134,988 | 4,363 | ........ | 332 | 681,895 | ........ |
| Total | 31,027 | 1,999,680 | 78,115 | 2,453 | 6,214 | 6,936,377 | 43,574 |

[1] Cherokee National Forest included in Tennessee.

The change from fiscal to calendar years in reporting number of stock grazed makes it impracticable to compare figures as to number of stock grazed in 1921 with figures for 1920. From such records as are available, however, the total number of stock grazed in the calendar year 1921 was less by approximately 470,000 cattle and horses and 165,000 sheep and goats than for the calendar year 1920, with about the same number of permittees, for the reason that financial considerations compelled owners to dispose of their salable stock and prevented replacement by desirable breeding stock. The demand for range, however, was as keen in 1921 as in any other year. Use of the forest ranges was less because of the necessity of relieving certain overstocked ranges and continuing the preferences of established permittees who were forced to liquidate.

### MEASURES NECESSITATED BY FINANCIAL CONDITION OF STOCK INDUSTRY.

Continued deflation and liquidation characterized the year 1921. The situation of cattle producers was particularly acute. Prices remained very low; operating expenses, while somewhat reduced, were still high, and no adequate means of financing the industry was available. Stock had to be sold for whatever it would bring, and the cattlemen were unable to find funds needed for range improvement and for the purchase of bulls to better their herds or to retain young female stock. The depression also prevented the usual and desirable movement of stock from the breeding sections in the Southwest to the ranges and ranches of the Northwest, so that forest ranges in the Southwest were materially overstocked with cattle for which no market was available, while surplus range existed in the Northwest.

For the sheep industry the outlook by the close of the summer season was exceedingly hopeful. A sudden rise in the lamb market and prospects of good prices for wool turned the disheartening situation of the early part of the year to one of extreme promise. The spring of 1922 proved to be all that could be desired in the way of markets, since wool and sheep of all kinds reached prices higher than before the war.

The general financial situation was materially relieved late in 1921 by extensions of credit from newly formed loan associations and through the reestablishment of the War Finance Corporation. Relief measures were also applied by the Forest Service. In many instances more stock were allowed to remain on the forests than the permanent capacity of the range justified, to avoid forcing the sale of beef at prices which would send the producers into bankruptcy. The usual reduction in the number of stock for which permits are given new owners coming into possession of the stock of permittees through transfers and sales was in many cases waived as a stabilizing measure. Permittees temporarily unable to maintain their preferences because forced liquidation left them without stock were given time to recuperate their losses and secure other stock without forfeiture of the grazing privilege. In recognition of the necessity the stockmen were under to cut down their operating expenses, many minor infractions of the regulations due to inadequate help on the ranges were overlooked and only aggravated cases were prosecuted under the trespass procedure. The lack of efficient help on the ranges, however, increased administrative difficulties materially, caused poor distribution of stock, and in some places resulted in a seriously overgrazed condition of parts of the range.

As explained last year, Congress afforded a further measure of relief through legislation postponing the payment of grazing fees, which are required under the regulations 30 days in advance of the opening of the grazing season.

The following table shows the amount delinquent on December 1, 1921:

| District No. | Number of permits, fiscal year 1921. | | | Delinquent. | |
|---|---|---|---|---|---|
| | Cattle and horses. | Sheep and goats. | Total. | Number of permits. | Amount. |
| 1 | 2,996 | 539 | 3,535 | 271 | $13,810.00 |
| 2 | 6,165 | 1,009 | 7,174 | 854 | 61,270.00 |
| 3 | 3,338 | 674 | 4,012 | 897 | 153,120.16 |
| 4 | 11,860 | 3,074 | 14,934 | 2,044 | 91,484.00 |
| 5 | 2,884 | 504 | 3,388 | 82 | 6,102.13 |
| 6 | 3,307 | 692 | 3,999 | 767 | 52,400.00 |
| 7 | 1,063 | 48 | 1,111 | 25 | 1,740.00 |
| Total | 31,613 | 6,540 | 38,153 | 4,940 | 379,926.29 |

To enable the stockmen to meet the above delinquency they were allowed to submit propositions of settlement and a note payable on or before July 1, 1922, with interest at 6 per cent. The outstanding indebtedness on July 1 was as follows:

| District No. | Number of delinquents. | Total amount. | Notes. | | No notes. | |
|---|---|---|---|---|---|---|
| | | | Number. | Amount. | Number. | Amount. |
| 1 | 38 | $3,564.31 | 33 | $2,777.16 | 5 | $787.15 |
| 2 | 102 | 9,643.30 | 51 | 4,118.11 | 51 | 5,525.19 |
| 3 | 200 | 40,329.10 | 123 | 33,495.72 | 77 | 6,833.38 |
| 4 | 316 | 19,803.49 | 206 | 17,173.90 | 110 | 2,629.59 |
| 5 | 8 | 730.45 | 2 | 499.80 | 6 | 230.65 |
| 6 | 58 | 3,926.75 | 24 | 2,529.26 | 34 | 1,397.49 |
| Total | 722 | 77,997.40 | 439 | 60,593.95 | 283 | 17,403.45 |

The conditions confronting the industry in 1922 had not sufficiently improved to warrant collection of the fees at the usual time. The regulations were therefore waived to allow payment to be made in two installments, one half on or before the date of entering the forest, and the other half on or before December 1, 1922.

### GOVERNING PURPOSES OF RANGE ADMINISTRATION.

Range administration by the Forest Service aims (1) to bring about the largest possible yield of live-stock products, (2) to promote settlement, and (3) to stabilize the live-stock industry dependent upon use of national forest ranges, on the basis of most efficient production. Realization of these ends requires regulation of use of the range by the stockmen, range improvements, and application of the best methods of range and live-stock management.

### POLICY UNDERLYING REGULATION OF USE.

Regulation of use of the range serves all three of the governing purposes. It increases the yield of live-stock products by control of the number and classes of stock allowed on the range, their distribution, and the period of use. It promotes settlement by its system of preferences, which enables the new settler to put stock on the forest ranges through reductions from time to time in the larger herds of established range users. Such reductions, however, are made gradually and will in no case go beyond the limits required for an efficient live-stock business under the specific local conditions existing. Finally, regulation of use helps stabilize the live-stock industry by lessening its hazards.

The open range live-stock industry of the West is one of extreme hazard. To secure permanence and stability of the business the ranges must have a sustained forage-producing capacity and stockmen must intrench themselves with ranch property and equipment to carry them over periods of depression or drought. Careful study has been given to the question how best to adjust the regulations to meet these needs.

### FURTHER ADJUSTMENT OF REGULATIONS NEEDED.

Agricultural lands, the public domain, and the national forest ranges are so interrelated that grazing administration of the latter must of necessity take into account the conditions created by the presence of lands of the other two classes. Little difficulty is experienced in adjusting the use of the forest ranges to agricultural development, but the absence of any form of control of the public domain creates a source of embarrassment and affords a prospect of disturbance likely to prove prejudicial both to the live-stock industry and to the public welfare.

On July 1, 1921, there were approximately 189,729,492 acres of unreserved unappropriated public domain, much of which has been largely depleted of vegetation by unregulated use. Much of this range adjoins or is in the vicinity of national forests. As its capacity gradually decreases, with no resultant decrease in numbers of stock, demands on forest range increase, administration becomes more difficult in preventing trespass, operating expenses to the individuals increase, and conflicts between owners result. In a word, the competition for the use of the remaining public domain is becoming so keen that a repetition of range wars and destruction of property can be expected unless legislation is enacted by which the public grazing lands outside the forests can be effectively administered.

It has already been explained that depressed business conditions necessitated leniency in requiring the removal of stock from ranges, the use of which had become in excess of their permanent carrying capacity. The problem involved presented the greatest difficulties in regions where drought increased the demand for range on the forests, lessened the production of forage, and made it impossible for the stockmen, had they been required to cut down the number of animals grazed on the forests, to find range elsewhere. The surplus stock must be removed at the earliest opportunity. This is necessary not only to maintain the productivity of the range but also to stabilize the industry. It is vital to the live-stock industry itself in these regions to have the carrying capacity of national forests fixed with a reasonable margin of security against the frequent years of deficient rainfall, shortage of feed, and consequent heavy losses in the herds of permittees.

In connection with this readjustment of use, the time is opportune to make some changes in the regulations which will aid materially both in financial readjustments and in the stability of further use of the range resource.

The regulations call for payment of grazing fees in advance. Stockmen usually meet operating expenses by borrowing, which involves paying interest until the loans can be repaid from receipts when stock is sold. Where yearlong range is used this may involve paying interest on the amount of the grazing fees for more than a year. All State and county taxes are payable in two installments, and Federal income taxes may be paid on the installment plan. It is believed equitable and advisable to adopt as a permanent policy payment for the use of yearlong ranges in two installments.

The present system of establishing the fee to be charged for the grazing privilege is not conducive to the best interests of the industry. It has not been based on a close scientific determination of the actual or commercial value of the forage, and stockmen have been unable to know what the fee might be year after year for a definite period. Further, the present fees do not sufficiently recognize differences in the relative value of the individual range units, due to their character and location.

As a necessary step to stabilization and permanency in the live-stock enterprises dependent upon the forests, a careful appraisal of all ranges is now under way and will be completed in 1923. This appraisal is based upon the quality and quantity of the forage; the amount and distribution of water; the character of the topography as it influences the management of stock or increases the probability of loss; the accessibility of the range to transportation, markets, and ranches or adjoining grazing land; the extent to which the range is improved with fences, corrals, pastures, roads, trails, and bridges; and the need for other improvements necessary to its fullest use. Data are also being collected and analyzed on the losses of live stock due to poisonous plants, predatory animals, straying, and other causes, and on operating expenses and the effect of national forest restrictions. All the information thus gathered with regard to conditions on the national forest ranges will be compared with similar information for private lands of known value, and the fee adjusted accordingly.

When the work is completed, and beginning with the grazing season of 1924, permits will be issued to fully qualified owners for not less than a five-year period. Such permits will authorize the grazing of not less than a stated number of live stock, which will be approximated to the number now permitted under established preferences and will be nonreducible during the period except for violation of the terms of the permit or in emergencies for the protection of the range. The primary purpose of such an arrangement is to stabilize the use of national forests by all classes of grazing permittees.

To stabilize further the use of national forest ranges and secure increased production of forage crops, permits will be predicated upon reasonable qualifications as to ownership of ranch property adequate to insure efficient live-stock production under local conditions.

### NEED OF RANGE IMPROVEMENTS.

Efficient administration of the national forest ranges is seriously hampered by the lack of range improvements essential to proper, full, and permanent use. Approximately $3,500,000 has been invested on national forest ranges by stockmen. This investment has made possible larger use of the resource, and larger receipts in grazing fees. While the construction of such improvements by stockmen has produced excellent results, the system is not altogether desirable from either the stockman's or the Government's standpoint. Improvements located on Government land under special-use permits do not justify large private investments. Further, the value to the stockman of these investments is considerably diminished by the fact that he may be required to make room for small owners desiring to share the use of the range. Under existing law there is no way by which, if this happens, reimbursement to the stockman who constructed the improvements can be made. The benefits, however, both to the stockmen and to the Government secured from these improvements prove conclusively the great importance of extending them.

The demand for range now fully equals and in many places overtaxes the capacity of the forests. To provide for increased demand, improve and protect existing ranges, and secure utilization of new areas, a large amount of improvement work must be undertaken by the Government. It is estimated that $3,500,000 will be necessary fully to improve the forest ranges. Projects have already been surveyed, on which construction can be begun immediately, involving an expenditure of over $170,000. These projects consist of boundary fences to prevent trespass, division and drift fences to control more adequately the distribution and movement of stock, water developments, and poisonous plant eradication. Such improvements as these are essential to the most effective range management and to providing for stable occupancy. The entire cost of these improvements will be returned to the Public Treasury in increased grazing receipts alone in about eight years, so that purely from a business standpoint the expenditure will be profitable—a fact which should not be overlooked.

### NEED OF IMPROVED METHODS OF MANAGEMENT.

The importance of improved methods of range and live-stock management, through which are obtained both more forage and more and higher-grade live-stock products, is apparent when it is borne in mind that about 53 per cent of all the sheep and 22 per cent of all the cattle in the 11 far Western States are grazed at least a part of the year on the national forests. The need for better methods of range management, whereby the quantity of forage available is increased and its most effective utilization promoted, is heightened by the increasing dependence of the western live-stock industry on the national forests for summer range. Agricultural settlement and the steady decline in carrying capacity of the public domain are destroying the balance between summer and winter feed. To meet the demands of the future the productivity of forest ranges must be raised.

This necessitates a more scientific knowledge of the resource. One of the requirements for developing inproved methods of management is exact knowledge of the character and present condition of all the ranges. This is obtained through a careful range reconnaissance and classification. The object of this work is to obtain and apply accurate knowledge of the carrying capacity of the range, the period during which forage can be used without injury, the class of stock to which the range is best adapted, whether sheep or cattle or both can use it without injury to the vegetation and secure maximum production of meat and wool, and how stock should be handled during different seasons of the year. With this knowledge management plans are developed which provide for deferred and rotation grazing, permitting a part of each range to be reseeded with the most valuable and nutritious species at regular intervals; salting plans, which regulate the distribution of stock on the range at proper seasons; the construction of improvements; and the most beneficial methods of herding.

To carry this work forward at the rate required an enlargement of the technical grazing personnel is essential. The grazing specialist is to grazing administration what the soil expert is to crop production, and more. He must know the species of vegetation most suitable to each locality and the class of stock which can be most economically produced on dependent range or farm lands; he must know the species of vegetation from which the greatest production of meat and wool can be derived; he must know when a forage crop can be harvested by grazing without injury to its permanency; he must develop methods of management suitable to the locality; and he must be able to work in harmony with stockmen and secure the adoption of such practices as will best meet the needs of both range and ranch property.

The results secured by the Forest Service with a limited number of these men during the past few years have fully demonstrated what can be done to meet the change in economic conditions. Many practical stockmen are beginning to employ this class of men in place of men whose sole qualification is the ability to ride a horse and rope a steer. The change, of course, is gradual, but it is placing range live-stock production on a higher level as a rationally conducted business. Western colleges have recognized the trend of the industry in the West, and are establishing courses in range management. There is urgent need on the national forests for more men trained along this line.

The need for intensive experiments and investigations to obtain additional knowledge in the light of which efficient use of the range can be still more fully brought about is discussed in the section of this report devoted to grazing studies.

### RECREATION AND GAME.

Motors and good roads have combined to effect a radical change in the outdoor recreation habits of the American people. Vacation time is now a period of free movement, nomadic enjoyment of widely separated scenes, and of simple living in the open. Rich in scenic beauty and natural charm and offering the primitive attractions of the wilderness, the national forests afford an incomparable field for the indulgence of this wholesome tendency toward rational play and physical improvement. Within their limits travelers by motors, by wagon, on horseback, or on foot, campers, hunters, and fishermen, amateur photographers, mountaineers, berry pickers, naturalists, and everybody else who wishes to come have equal opportunity. Care with fire and cleanliness in camp are the only requirements imposed upon their sojourn.

The wide distribution and extent of the national forests and their proximity to thousands of cities and communities make them natural centers of summer recreation, particularly for the masses of people whose vacation must be inexpensive. Between 5,000,000 and 7,000,000 people visit the forests each year. The discouragement of recreational use of the forests would therefore be a distinct hardship, and failure to develop recreational possibilities would mean withholding a form of public service which, though intangible in value, ranks in social and indeed economic importance with the timber, forage, and water-power values of these properties. Public welfare dictates an aggressive policy of ascertaining, developing, and offering the recreational opportunities in the national forests.

The close relationship between county or municipal welfare and near-by forests is illustrated by the action of counties such as Gila County, Ariz., and Fresno and Mariposa Counties, Calif., and of cities such as Denver, Salt Lake City, Los Angeles, and Butte, whose programs of county or municipal development provide for maintaining county or municipal camps and camp grounds within the national forests. Community projects of this character are often supplemented by corporate and organizational undertakings, exemplified by the plans of copper companies in Arizona to construct summer camps for their employees at cool altitudes within the forests, and of stakes of the Mormon Church to build and maintain forest camps, such as that of the Mutual Dell Community near Salt Lake City, for the use of members of the young men's and young women's societies. And for every project of this character there are thousands of families who turn to the forests yearly to tent on a general camp ground or a secluded spot of their own choosing, or to occupy a summer home constructed under permit from the service.

This growing use means for the national forests new opportunities of service of immeasurable public value. It should be strongly encouraged. The fact that it entails obligations must, however, be recognized. The assemblage of large numbers of people at points of interest creates problems of fire protection, of sanitation, and of supervision that can not be disregarded without serious consequences to the safety of the forests and to public health. Within several States certain specific requirements are made compulsory on private lands to safeguard public health. The Federal Government should not be above such laws, nor can it throw the entire burden of their observance upon counties, municipalities, and private agencies, although a large measure of cooperation is secured from those sources. More liberal appropriations are absolutely necessary to install upon the national forests the sources of pure-water supply, fireplaces, toilets, garbage pits, and other simple facilities required for public health and comfort and reasonable security against fire. The estimate for the fiscal year 1924 of $20,000 for these purposes will amount to an expenditure of less than one-third of 1 cent for each person who uses the national forests for recreation.

The 157,000,000 acres within the national forests, of wide geographical distribution, embrace in part the natural ranges of every species of wild life known to have existed in the continental United States. Of the great wealth of game which at one time abounded in the United States only a comparatively small remnant remains. There is scarcely any species that has not been severely depleted. Any serious attempt to preserve for future generations a part of the abundant wild life with which this country was once generously endowed will depend to a substantial degree upon publicly owned lands, and particularly upon the national forests.

Settlement and intensive cultivation of nonforested lands have operated to make wild life peculiarly a product of forest land and its preservation and perpetuation a major problem of forest management. Only by a thoroughgoing correlation between the industrial uses of the forest and the food and shelter requirements of game animals and birds can the latter be saved from extinction. There is economic justification for such correlation in that game is a forest resource of material importance. Recognition of game as a forest product and the practicability of its administration by the Federal Government are evidenced by the action of several Eastern States in ceding to the Federal Government the right to regulate the taking of game upon forest land acquired by the Government. Such action has in no way decreased the interest of these States in the game situation, but has strengthened the relationship between the State and Federal agencies.

A sustained and increasing annual yield of game may be permanently secured without impairment of the stock, and depleted areas may be restored either by distribution or by the regulation of or temporary restriction upon hunting. There are many noteworthy examples of possibilities along these lines. One is the beaver, whose introduction and protection have often led to such increases in numbers that reduction through regulated trapping frequently becomes necessary to check serious injury to property. Another is the deer, which under reasonable regulation makes marvelous gains in numbers, with a constant increase in hunting opportunities. The Federal game refuge created in 1906 within the Kaibab National Forest, in northern Arizona, and administered by the Forest Service, affords an excellent example of the capacity of deer to multiply rapidly under protection. The number of deer upon this area is not accurately known, but estimates now range from 10,000 to 30,000 head, despite yearly migrations to adjoining regions. To the motorist traversing this forest, deer are a common sight, frequently outnumbering the domestic cattle observed en route. Comparable results are obtainable with other species and in other regions. Experience conclusively demonstrates that wild life responds quickly to simple and rational forms of management and that reasonable regulation does not reduce, but in the long run markedly increases, the amount of game which may be taken annually. The significance of this is that the national forests, without any impairment of their present purposes, can be made to contribute greatly to the pleasure and profit of the public through more aggressive development of their capacity to produce game animals, birds, and fish. The promotion of healthful, vigorous types of sport would alone justify the effort required. There are also large economic possibilities of food and fur production, which systematically developed would annually contribute toward our national needs millions of dollars' worth of meat and skins.

As a first step in determining the requirements of wild life on the national forests, an effort has been made to secure reliable data on the number and species of game animals. Estimates so far submitted on the more important big-game species indicate that the national forests contain nearly half a million deer of several species, reported as existing on 86 forests. Elk formerly occurred in nearly every State, but the larger number are now confined to national forests and national parks in 14 States. Of a total of 72,000 elk reported in existence in the United States several years ago, a majority find range on the national forests some time during the year. The once large herds of antelope found in all Western States have been almost annihilated, but the 2,400 head now existing on the national forests in 10 States constitute the nucleus of future herds. A total of 13,000 mountain sheep in 11 States, and 10,000 mountain goats in 4 States are reported. A few representatives of many other big game species are still found in widely scattered sections of the national forests, while fur-bearing animals under protection show a remarkable increase in most localities.

As a second step in the development of game management plans, 97 State game refuges, involving approximately 11,000,000 acres, have been established. Supplementing these are 4 Federal refuges, containing approximately 773,925 acres, within the boundaries of the national forests. In addition to these State and Federal refuges, there is an almost equal acreage upon which the grazing of domestic stock has been restricted so as to provide an ample supply of forage for game. All State and Federal game refuges are natural breeding grounds, and since all hunting on them is forbidden by State or Federal law, adjacent territory is being restocked by the overflow from these refuges.

To promote better cooperation and organization in game protection, informal agreements have been entered into with State game officers in most of the national forest States. These agreements provide for the appointment of qualified forest officers as deputy State game wardens. They also provide for the presentation of annual reports to the governor or the State game commission wherein information regarding game conditions is presented in detail, with specific recommendations for changes in game laws or on other matters relating to the welfare of the game. Under this arrangement there is a strict enforcement of the game laws by forest officers, who, in 1921, made 170 arrests for violation of the game laws, with 94 convictions resulting, and who reported to State officials 28 violations, with 13 convictions resulting. The findings and recommendations contained in the annual reports have frequently been used by State officials in recommending or shaping new legislation.

Through the cooperation of the National Park Service, the Biological Survey, and the Montana Fish and Game Commission, the Yellowstone herds of elk were given excellent protection, which, coupled with rather favorable winter conditions, reduced the usual loss to almost a minimum. However, the situation confronting these herds during severe winters continues to be critical and can only be ameliorated by the acquisition of winter-range lands as indicated in the report for 1921.

The many State and local fish and game protective associations are most valuable agencies in the protection and development of the game resources and are the media through which favorable public sentiment toward adequate game protection is most effectively promoted. Their membership includes the naturalist, the game enthusiast, the stockman, and men engaged in business enterprises of all kinds. Many conflicting interests may be effectively reconciled through such organizations. Their extension into all localities can not be too strongly encouraged. As these many small organizations become more closely affiliated with those of national importance the effectiveness of their cooperation greatly increases.

No greater stimulus for recreation can be found than a stream or lake well stocked with game fish; but through increased use many streams once plentifully stocked are becoming depleted. To meet rapidly increasing use and maintain fish production, carefully prepared plans for securing, transporting, and planting fry or fingerlings must be executed. These plans show the species inhabiting the stream, the quantity and kinds of fish food, the species to which the stream is best adapted, and the number of fry required yearly. Because of the loss usually occurring in transplanting small fry, it is sometimes necessary to establish rearing ponds where the young fry may be fed until they are large enough to be released into mountain streams. These rearing ponds with their thousands of small fish may be seen on many of our national forests. In this connection the periodic closure or alternation in the use of streams frequently is necessary, and is secured through orders by the State game officials.

During the year each national forest district completed plans for the stocking of streams on one or more national forests, and in cooperation with the Bureau of Fisheries and the several State hatcheries real progress was made in stocking streams and lakes in which no fish have hitherto been found, and in replenishing the supply in favorable or accessible streams and lakes frequented by many campers and sportsmen. In Colorado the Forest Service received 4,173,000 trout fry from State hatcheries and 776,000 trout fry from Federal hatcheries, which were successfully planted in streams and lakes within the national forests, the normal loss in transporting being cut by over 25 per cent.

Fish and game management plans are being developed on all forests as fast as funds and personnel will permit. Their objective are: The preservation of adequate spawning and breeding stocks; control of environmental factors inimical to productiveness; and promotion of public sentiment, laws, and organizations necessary to the proper protection and development of wild life. These plans call for a high degree of expert knowledge and study in order that conflicting interests may be properly reconciled. The advice and assistance received from the Biological Survey has contributed materially to their development. The views of the game enthusiast must be harmonized with those of the sportsman, stockman, and lumberman. Each must recognize the problems of the other, and through cooperation assist in the proper management of the resource.

### WATER POWER.

During the second year of operation under the Federal water power act of June 10, 1920, 45 applications were received for use of land within or partly within the national forests. The number for the preceding year was 124. The passage of a new law naturally stimulates action to take advantage of it, so that more applications are to be expected the first year than subsequently. Moreover, previous laws offered insufficient tenure to attract investments in water power and therefore tended to retard development, especially where the applicant company had no established market. Construction under earlier laws was restricted in a very considerable measure to extensions of systems already operating. The Federal water power act greatly encouraged new water power development, and a large proportion of the applications received are from new companies.

The tabulation following contains data concerning water power permits or easements granted by the Department of Agriculture under former legislation and in effect on June 30, 1922.

*Water-power development and transmission-line rights of way under permit or easement fiscal year 1922.*

| Class of permits or easements. | Transmission lines only. | | | Power projects (reservoirs), conduits, and power houses. | | |
|---|---|---|---|---|---|---|
| | Number of permits or easements. | Within national forest boundaries. | On national forest land. | Number of permits or easements. | Estimated average output (in horsepower) at minimum discharge. | Total number permits or easements. |
| Permits or easements in force at close of fiscal year: | | | | | | |
| Rental— | | *Miles.* | *Miles.* | | | |
| Preliminary | | | | 1 | 772 | 1 |
| Final | 151 | 1,158.60 | 872.30 | 87 | 658,829 | 238 |
| Free permits or easements | 24 | 156.21 | 128.64 | 95 | 27,338 | 119 |
| Total | 175 | 1,314.81 | 1,000.94 | 183 | 686,939 | 358 |
| Construction completed at close of fiscal year: | | | | | | |
| Rental permits or easements | 151 | 1,158.60 | 872.30 | 74 | 308,990 | 225 |
| Free permits or easements | 24 | 156.21 | 128.64 | 81 | 9,934 | 105 |
| Total | 175 | 1,314.81 | 1,000.94 | 155 | 318,924 | 330 |
| Construction incomplete at close of fiscal year: | | | | | | |
| Rental permits or easements | | | | 12 | 346,210 | 12 |
| Free permits or easements | | | | 13 | 17,389 | 13 |
| Total | | | | 25 | 363,599 | 25 |
| Construction not started at close of fiscal year: | | | | | | |
| Rental permits or easements | | | | 2 | 4,401 | 2 |
| Free permits or easements | | | | 1 | 15 | 1 |
| Total | | | | 3 | 4,416 | 3 |

In the report of last year mention was made of the burden placed upon the Forest Service by the requirement of the Federal water power act that the work of the Federal Power Commission shall be performed largely by the Departments of War, Interior, and Agriculture. Although the volume of work handled by the Forest Service for the Federal Power Commission is far greater than its own water-power business before the commission was created, no provision for meeting the increased cost has been made, and it has been necessary to draw on funds needed for other work. During two years under the Federal water power act 105 applications have been referred to the Forest Service for engineering investigation and report, and at the request of the commission it is supervising and inspecting the operations of 52 permittees or licensees. Although every effort has been made to expedite the work of the Federal Power Commission and nearly every engineer in the Forest Service qualified for water-power examinations has spent a large portion of his time thereon, there were, on June 30, 40 applications upon which report had not been made. During the year 48 cases were reported upon and 36 cases were referred to the Forest Service for engineering examination.

### ROADS AND TRAILS.

Road and trail work in the national forests was actively prosecuted and a material advance made toward the transportation system necessary for public travel and for the administration and protection of the forests. While an immense amount of construction remains to be done and many years will elapse before the system is completed, during the calendar year 1921, 1,104 miles of road and 2,959 miles of trail were constructed or improved, and 3,007 miles of road and 4,294 miles of trail were maintained. These mileages include not only the more important and costly work performed under the supervision of the Bureau of Public Roads, but also the comparatively simple and inexpensive work done directly by the Forest Service. The figures on accomplishments and expenditures follow:

*Construction, improvement, and maintenance of roads and trails from forest road appropriations and other Federal and cooperative funds by States.*

| State. | Calendar year 1921. | | Total to Dec. 31, 1921. | | | Expenditures to Dec. 30, 1921. | | |
|---|---|---|---|---|---|---|---|---|
| | Roads constructed. | Trails constructed. | Roads constructed. | Trails constructed. | Roads and trails maintained. | Federal. | Cooperative. | Total funds. |
| | *Miles.* | *Miles.* | *Miles.* | *Miles.* | *Miles.* | | | |
| Alabama | | | | | 10.0 | $733.50 | | $733.50 |
| Alaska | 22.4 | 17.2 | 62.6 | 57.3 | 37.5 | 485,096.81 | $164,806.16 | 649,902.97 |
| Arizona | 85.2 | 268.5 | 295.3 | 481.1 | 209.0 | 845,736.87 | 648,892.93 | 1,494,629.80 |
| Arkansas | 9.7 | 28.7 | 78.9 | 46.1 | 227.7 | 237,129.13 | 24,184.93 | 261,314.06 |
| California | 79.8 | 221.5 | 333.8 | 619.2 | 4,030.0 | 2,298,906.26 | 679,900.58 | 2,978,806.84 |
| Colorado | 77.9 | 228.3 | 331.2 | 467.6 | 137.8 | 1,400,792.50 | 433,452.81 | 1,834,245.31 |
| Florida | .2 | | 45.2 | | 42.0 | 70,291.41 | 56,600.00 | 126,891.41 |
| Georgia | 7.5 | 19.8 | 8.5 | 32.8 | 80.0 | 116,610.95 | | 116,610.95 |
| Idaho | 139.6 | 428.9 | 711.2 | 1,010.9 | 338.9 | 2,134,207.01 | 874,705.35 | 3,008,912.36 |
| Kansas | | | 3.4 | | | 2,111.51 | | 2,111.51 |
| Maine | | | | 30.0 | 35.0 | 6,169.42 | | 6,169.42 |
| Michigan | 7.1 | | 40.4 | | | 3,263.26 | 186.95 | 3,450.21 |
| Minnesota | 22.0 | 29.0 | 30.4 | 29.0 | 78.7 | 90,798.53 | 90,905.11 | 181,703.64 |
| Montana | 29.6 | 29.6 | 230.7 | 202.9 | 316.1 | 1,312,502.75 | 362,122.50 | 1,674,625.25 |
| Nebraska | 15.0 | | 23.8 | | 7.0 | 8,637.32 | | 8,637.32 |
| Nevada | 46.8 | 79.5 | 217.6 | 170.0 | 92.2 | 177,378.53 | 93,773.75 | 271,152.28 |
| New Hampshire | 2.0 | 23.0 | 5.0 | 235.0 | 246.0 | 19,285.69 | 220.25 | 19,505.94 |
| New Mexico | 53.8 | 147.2 | 229.2 | 464.7 | 145.8 | 820,185.75 | 179,095.32 | 999,281.07 |
| North Carolina | 14.4 | 14.5 | 51.7 | 45.5 | 350.6 | 177,787.71 | 31,951.17 | 209,738.88 |
| North Dakota | | | 1.0 | | | 65.75 | | 65.75 |
| Oklahoma | | | | | 20.0 | 6,230.81 | 925.00 | 7,155.81 |
| Oregon | 155.5 | 180.2 | 734.1 | 524.0 | 685.0 | 1,790,199.16 | 1,383,813.77 | 3,174,012.93 |
| Porto Rico | | | | 20.0 | 20.0 | 3,356.11 | | 3,356.11 |
| South Carolina | 5.3 | | 5.3 | | 5.3 | 47,310.43 | 11,000.00 | 58,310.43 |
| South Dakota | 23.3 | 17.6 | 66.1 | 20.6 | 26.9 | 168,691.53 | 90,638.93 | 259,330.46 |
| Tennessee | 8.0 | 13.0 | 11.7 | 28.5 | 211.0 | 76,258.57 | 64,559.38 | 140,817.95 |
| Utah | 155.0 | 106.5 | 709.5 | 595.2 | 173.3 | 856,841.75 | 533,001.06 | 1,389,842.81 |
| Virginia | | | 4.0 | 50.5 | 322.0 | 31,382.73 | 2,409.91 | 33,792.64 |
| Washington | 58.7 | 40.0 | 270.5 | 314.0 | 588.0 | 1,426,246.31 | 835,696.29 | 2,261,942.60 |
| West Virginia | | | | | 141.0 | 1,319.54 | | 1,319.54 |
| Wyoming | 85.6 | 1,066.0 | 284.6 | 1,265.8 | 167.5 | 809,302.61 | 229,051.32 | 1,038,353.93 |
| Total | 1,104.4 | 2,959.0 | 4,785.7 | 6,710.7 | 8,744.3 | 15,424,830.21 | 6,791,893.47 | 22,216,723.68 |

Congress has now passed four measures appropriating money for road and trail construction in the national forests. The first of these was contained in the agricultural appropriation act of March 4, 1912, which appropriated 10 per cent of the receipts from the national forests in any State for road and trail construction within the national forests of that State. The provisions of this legislation were well adapted to national forest transportation needs, except that it is frequently necessary to improve roads and trails which are not entirely within the forest boundaries; but it soon became evident that the amount annually made available was far too small to meet the requirements both of the forests and of the local public.

The act of July 11, 1916, therefore, appropriated $10,000,000, at the rate of $1,000,000 annually, for roads and trails within or partly within the national forests when necessary for the use and development of resources upon which communities within or adjacent to the forests are dependent. The act provided that the expenditures in any forest constitute a liability against 10 per cent of the future receipts from that forest, and it limited the expenditures to 10 per cent of the value of national forest timber and forage within the county or counties where the road is located. Application for aid must be filed by the properly constituted State or county authorities, and cooperation in an equitable amount is a requisite before Federal money can be spent upon a project.

While this fund may legally be used for roads developing forest as well as other resources, there was a great need for roads and trails required primarily for the administration and protection of the national forests. On February 28, 1919, $9,000,000 was appropriated, to be expended in cooperation with the local authorities for roads and trails necessary for the national forests or which were of national importance.

In the meantime the interest in the construction of better roads throughout the Nation had become widespread, and there was a general demand for Federal aid on roads traversing the national forests, which form links in State and county highway systems. The forest road legislation previously enacted did not specify the proportion of the total appropriations which should be expended upon roads constructed primarily for the use of the public. Since the need for these roads was very evident, and since it was found almost impossible to get local cooperation on the roads and trails primarily required for the protection of the forests themselves, a large portion of the total appropriations was expended on the roads of primary importance to public travel and the development of the administrative and utilization road system did not advance as fast as the conditions required.

The action taken by Congress in the Federal highway act of November 1, 1921, meets the requirements of national forest road construction very satisfactorily, and the present legislation will probably answer the needs for many years to come. The outstanding feature of this legislation is a recognition that forest-road funds are required (1) for the administration, protection, and development of the Government's own properties in order that they may not only be safeguarded but also made of maximum service to the public; (2) for aid to the States and counties in the construction of roads which are essential links in the public-highway system. Separate appropriations were made by Congress for these two classes of roads, and while the Secretary of Agriculture is permitted to accept cooperation, financial assistance is not required.

By section 23 of the Federal highway act, $5,000,000 was made immediately available for Forest roads and trails and $10,000,000 was made available on July 1, 1922. The act provides that $2,500,000 of the first appropriation and $3,000,000 of the second, or in other words a total of $5,500,000, shall be used for roads and trails of primary importance for the protection, administration, and utilization of the national forests, or, when necessary, for the use and development of the resources upon which communities within or adjacent to the national forests are dependent. This appropriation has been designated as the forest-development fund. In accordance with the provisions of the act, it has been apportioned to the several States, Alaska, and Porto Rico according to the relative needs of the various national forests, taking into consideration the existing transportation facilities, value of timber and other resources served, relative fire danger, and comparative difficulties of road and trail construction. Congress designated that the remainder of the total appropriation, $9,500,000, should be used for forest roads of primary importance to the States, counties, or communities within, adjoining, or adjacent to the national forests, and stipulated that it be apportioned to the States and Territories according to the area and value of the national forest land. This appropriation has been designated as the forest-highway fund. The condition of the five respective forest-road appropriations on January 1, 1922, was as follows:

*Condition of road appropriations.*

| Fund. | Total appropriations to December 31, 1921. | Total expenditures. | Unexpended balance. |
|---|---|---|---|
| 10 per cent | $3,042,248.40 | $2,678,226.43 | $364,021.97 |
| Section 8 | 6,000,000.00 | 4,515,539.80 | 1,484,460.20 |
| Federal forest road construction | 9,000,000.00 | 7,611,429.74 | 1,388,570.26 |
| Forest highway | 2,500,000.00 | | 2,500,000.00 |
| Forest development | 2,500,000.00 | | 2,500,000.00 |
| Total | 23,042,248.40 | 14,805,195.97 | 8,237,052.43 |

The distribution among States of the appropriations available for expenditure prior to July 1, 1922, and of the appropriations which on that date were made available for expenditure is shown in the following tabulation:

*Distribution among the States of the total appropriations and of the appropriation for the fiscal year 1923.*

| State. | 10 per cent fund. | | Section 8 fund. | | Federal forest road construction fund total. |
|---|---|---|---|---|---|
| | Fiscal year 1923. | Total. | Fiscal year 1923. | Total. | |
| Alabama | $70.58 | $272.52 | (1) | $60.00 | $712.37 |
| Alaska | 4,574.34 | 73,958.73 | $42,092 | 327,318.43 | 189,125.23 |
| Arizona | 27,819.50 | 362,035.78 | 57,293 | 420,785.60 | 455,304.40 |
| Arkansas | 3,122.62 | 50,153.52 | 10,243 | 99,912.16 | 141,288.55 |
| California | 62,876.54 | 480,299.33 | 127,714 | 1,029,680.11 | 1,132,744.01 |
| Colorado | 30,344.24 | 344,552.20 | 69,894 | 522,575.07 | 762,500.61 |
| Florida | 2,409.37 | 16,305.61 | (2) | 69,092.67 | 25,247.49 |
| Georgia | 629.15 | 2,667.59 | (1) | 303.17 | 119,893.01 |
| Idaho | 39,096.47 | 407,422.36 | 117,097 | 814,934.67 | 1,366,208.87 |
| Kansas | | 1,977.32 | | | |
| Maine | 112.23 | 761.62 | (1) | 169.01 | 3,604.79 |
| Michigan | 21.95 | 741.34 | (2) | 15.00 | 3,000.00 |
| Minnesota | 260.47 | 13,482.12 | (2) | 613.65 | 108,136.76 |
| Montana | 23,040.05 | 358,151.52 | 67,608 | 530,048.89 | 748,000.60 |
| Nebraska | 404.41 | 10,080.20 | (2) | 26.98 | |
| Nevada | 5,676.53 | 89,050.21 | 18,002 | 139,440.55 | 105,250.57 |
| New Hampshire | 1,421.00 | 9,845.80 | (1) | 181.10 | 10,681.46 |
| New Mexico | 17,990.25 | 222,075.84 | 39,055 | 301,261.61 | 513,159.72 |
| North Carolina | 3,023.58 | 12,930.46 | (1) | 59,755.99 | 185,315.32 |
| North Dakota | | 156.79 | | 15.00 | |
| Oklahoma | 158.87 | 4,641.60 | (2) | 49.45 | 2,570.39 |
| Oregon | 44,006.09 | 375,651.22 | 122,967 | 937,315.60 | 994,458.32 |
| Porto Rico | | 3.70 | (2) | 15.00 | 3,336.11 |
| South Carolina | 48.56 | 304.46 | (1) | 60.00 | 47,206.13 |

[1] Group II.

[2] Group I.

*Distribution among the States of the total appropriations and of the appropriation for the fiscal year 1923*—Continued.

| State. | 10 per cent fund. | | Section 8 fund. | | Federal forest road construction fund total |
|---|---|---|---|---|---|
| | Fiscal year 1923. | Total. | Fiscal year 1923. | Total. | |
| South Dakota | $5,938.43 | $67,929.92 | $7,819 | $58,709.24 | $76,910.09 |
| Tennessee | 1,373.58 | 7,231.56 | (1) | 57,207.39 | 27,949.75 |
| Utah | 15,903.14 | 215,904.51 | 39,223 | 314,259.78 | 471,583.37 |
| Virginia | 2,296.11 | 11,950.72 | (1) | 41,120.38 | 71,844.26 |
| Washington | 27,721.45 | 212,148.76 | 86,550 | 674,728.32 | 707,629.15 |
| West Virginia | 242.64 | 1,478.41 | (1) | 128.64 | 2,149.80 |
| Wyoming | 17,994.81 | 187,895.97 | 47,006 | 315,370.12 | 540,026.37 |
| Group I | | | 13,981 | 13,981.00 | |
| Group II | | | 33,456 | 33,456.00 | |
| Special fund | | | 100,000 | 217,379.42 | |
| Equipment and administration expense | | | | | 184,162.50 |
| Total | 338,576.96 | [3] 3,542,061.69 | 1,000,000 | 7,000,000.00 | 9,000,000.00 |

| State. | Forest highway fund. | | Forest development fund. | | Grand total. |
|---|---|---|---|---|---|
| | Fiscal year 1923. | Total. | Fiscal year 1923. | Total. | |
| Alabama | $3,590 | $4,880 | $3,163 | $5,799 | $11,723.89 |
| Alaska | 711,998 | 970,271 | 27,394 | 50,222 | 1,610,895.39 |
| Arizona | 444,049 | 598,189 | 153,121 | 280,722 | 2,117,036.78 |
| Arkansas | 51,729 | 70,365 | 39,585 | 72,573 | 434,322.23 |
| California | 1,065,108 | 1,460,871 | 383,903 | 703,822 | 4,807,416.45 |
| Colorado | 536,519 | 717,058 | 183,469 | 336,360 | 2,683,045.88 |
| Florida | 18,470 | 25,118 | 4,762 | 8,730 | 144,493.77 |
| Georgia | 9,814 | 13,355 | 11,098 | 20,347 | 156,565.77 |
| Idaho | 818,950 | 1,097,894 | 593,812 | 1,088,656 | 4,775,115.90 |
| Kansas | | | | | 1,977.32 |
| Maine | 2,029 | 2,760 | 2,593 | 4,754 | 12,049.42 |
| Michigan | 2,695 | 3,638 | 3,393 | 6,220 | 13,614.34 |
| Minnesota | 45,152 | 60,929 | 35,793 | 65,621 | 248,782.53 |
| Montana | 644,792 | 878,886 | 313,426 | 574,615 | 3,089,702.01 |
| Nebraska | 8,141 | 11,065 | 6,086 | 11,159 | 32,331.18 |
| Nevada | 152,632 | 207,984 | 30,205 | 55,377 | 597,102.33 |
| New Hampshire | 25,951 | 35,294 | 13,241 | 24,276 | 80,278.36 |
| New Mexico | 338,619 | 458,258 | 119,810 | 219,652 | 1,714,407.17 |
| North Carolina | 20,486 | 27,856 | 25,627 | 46,984 | 332,841.77 |
| North Dakota | | | | | 171.79 |
| Oklahoma | 4,150 | 5,645 | 4,791 | 8,764 | 21,670.44 |
| Oregon | 846,360 | 1,157,109 | 391,939 | 718,555 | 4,203,089.14 |
| Porto Rico | 1,069 | 1,451 | 2,911 | 5,344 | 10,152.81 |
| South Carolina | 1,156 | 1,572 | 4,747 | 8,704 | 57,846.59 |
| South Dakota | 57,042 | 77,553 | 34,985 | 64,139 | 345,241.25 |
| Tennessee | 15,136 | 20,896 | 12,678 | 23,243 | 136,527.70 |
| Utah | 273,247 | 371,776 | 89,595 | 164,258 | 1,537,781.66 |
| Virginia | 19,199 | 26,140 | 25,369 | 46,512 | 197,567.36 |
| Washington | 518,263 | 708,133 | 328,848 | 602,889 | 2,905,528.23 |
| West Virginia | 4,453 | 6,051 | 7,965 | 14,602 | 21,409.85 |
| Wyoming | 359,201 | 479,000 | 145,691 | 267,101 | 1,789,393.46 |
| Group I | | | | | 13,981.00 |
| Group II | | | | | 33,456.00 |
| Special fund | | | | | 217,379.42 |
| Equipment and administration expense. | | | | | 184,162.50 |
| Total | 7,000,000 | 9,500,000 | 3,000,000 | 5,500,000 | 34,542,061.69 |

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[1] Group II.

[3] Includes $161,236.33 deferred grazing fees for fiscal year 1922.

The selection of projects for current construction and the development of the entire forest road system are handled in close cooperation with the Bureau of Public Roads and the highway commissions of the States concerned. All road projects of high standards, requiring technical highway engineering, are surveyed and built under the direction of the Bureau of Public Roads. The trails and inexpensive low-grade roads are built by the Forest Service, utilizing its field organization of forest supervisors and rangers.

To carry on highway work most efficiently it is necessary that the program be determined at least one year, and preferably two years, prior to the beginning of construction. The program for the 1924 construction season is now under consideration but can not be definitely determined upon until the appropriations for the year are known. Congress has recognized the adaptability of the legislation contained in section 23 of the Federal highway act and has authorized an annual appropriation of $6,500,000 for expenditure under the provisions of that section for the fiscal years 1924 and 1925.

A comprehensive study is now being made of the road needs of the national forests under the two classes of forest roads specified in the Federal highway act. The figures available indicate that to complete the necessary system of forest development roads and trails, 13,560 miles of roads and 37,114 miles of trails must be constructed, at an estimated expenditure of $64,693,000. For the system of forest highways of primary importance to the States, counties, and communities, the rough survey indicates that $107,658,000 must be expended for construction or improvement. If the present current appropriations are continued, it appears possible to complete the development of an adequate road system within the national forests, covering all requirements, in from 20 to 26 years.

### MAPS AND SURVEYS.

Accurate maps of the national forests are essential to every activity conducted by the service. For the successful direction of forest-fire detection and suppression it is vitally important that topographic features and improvements such as ranches, telephone lines, roads, trails, and other means of communication and transportation be accurately delineated. Topographic maps are also needed in connection with timber sales and the management of grazing business. The increasing use of the forests for recreation has greatly multiplied the demand for maps by the public.

The foundation essentials for accurate maps are precise, detailed topographic surveys. These surveys are executed by the United States Geological Survey after the Coast and Geodetic Survey has extended the necessary judiciary control. Small fragmentary sections of the forests have from time to time been mapped by the Forest Service in connection with timber sales or other activities which require immediate data. The service cooperates with and assists the Geological Survey in every possible way, including financial aid whenever available, in surveying and mapping the national forests.

At present, of the 181,799,997 acres included within the forest boundaries, 20 per cent is accurately mapped, and 56 per cent has been covered by rough reconnaissance, leaving about 24 per cent upon which no work has been done. This means that surveys are needed upon 80 per cent of the national-forest areas to permit the compilation of accurate and reliable maps.

Ordinarily, maps are printed upon three scales—one-quarter, one-half, and one inch to the mile, depending upon the available and desired detail. All Forest Service men on field work carefully check up errors which appear upon the maps, note corrections which come to their attention, recommend to the United States Geographic Board names for unnamed topographic features, and currently gather new and more detailed data for inclusion upon the maps. After sufficient information has been secured to warrant a revision, new maps are prepared and published.

## RESEARCH.

Forest research is revealing more clearly each year the gigantic outline of our forest problems, and has begun in a small way to unravel the myriad technical puzzles that confront us in the revolution from timber mining to timber growing. Its broad aim is to obtain the knowledge necessary for the best use of our forest land and of what it can be made to grow. This calls for both technical and economic research. The two are complementary. We must know what we shall need to produce; and what we shall need depends on how we utilize the products of our forests. It is impossible to deal with production independently of utilization. Forestry, like agriculture (of which it is a subdivision), must concern itself not merely with the technique of production, but with the business of land management and crop marketing, and the economic requirements and industrial practices that integrally shape that business.

Neither the purpose of the research work of the Forest Service nor its practical importance and necessary scope can be understood without recognition of these facts. A sound national policy of forestry can not reach full fruition until far more is known about how to grow timber under widely varying conditions, what our economic and industrial requirements are, and by what methods of use these requirements can most satisfactorily and with least waste be met. In the course of about 75 years most of our enormous natural wealth in virgin timber has been consumed or converted into other forms of capital. With industrial progress our per capita consumption of timber increased until, a few years ago, advancing prices and depletion of supplies turned the tide. We are still living mainly on our forest capital; and to meet our current needs we are not merely draining the insufficient reservoir of remaining mature timber, but also drawing heavily on growing stock that has not reached saw-timber size. The accident of a sudden crisis less than three years ago sent lumber prices temporarily skyward so fast that public attention was sharply drawn to the situation and an inquiry ordered. The crisis passed, but the inquiry made clear that the Nation had experienced a brief preliminary symptom of the economic stringency which must come as the full consequences of our past and present course work out. The availability of accurate information is essential to every effort in the whole slow process of restoring the balance between timber use and timber growth.

### SILVICAL INVESTIGATIONS.

Nowhere is there a greater need for knowledge of timber growing than in the eastern United States, where the relatively dense population, the enormous industrial demands for timber, and the large areas of land best fitted for forests all unite to urge timber production on a large scale. Here, where its results are most certain to be immediately and widely applied, Federal forest research has but made a beginning. The Southern and the Appalachian Forest Experiment Stations have now been in operation a little more than a year, have organized their staffs, have taken a rapid survey of their fields, and have concentrated their efforts on the problems that are most urgent—such as the amount of loss from forest fires, simple methods of cutting to assure natural reproduction, and studies of the growth and yield of timber, the effects of grazing on forest reproduction, and improved methods of turpentining. These investigations will help in the management of the national forests in the Southeast, but their outstanding significance will be in relation to the vastly larger areas of timberlands in private ownership.

These two stations cover only part of the eastern forests; two other great forest regions, New England and the Lake States, are equally in need of forest experiment stations, and there is a rapidly growing public recognition of this need in both regions. It is the aim of the Forest Service to establish them as soon as the necessary appropriations can be secured.

There has been much discussion in recent years of public regulation of all forest lands. There is urgent need for more exact knowledge than we now have as to what public regulation might fairly and reasonably require and what it might accomplish in growing timber. The Forest Service has undertaken to answer these questions in the main forest types of the country. Going further, this investigation also seeks to establish what might be termed "desirable forestry practice"—that is, the things that must be done not merely to keep forest lands reasonably productive, but to produce good qualities and higher yields of timber. These two projects, nation-wide in scope, aim to deal in a broad way with the immediate questions arising in the reforestation of the 83 per cent of our forest lands in private ownership.

Side by side with this extension of research into new regions and broad problems has come the fruition of intensive investigations in regional forestry problems of great importance. In the Southwest and the Pacific Northwest, for example, 10 years of patient study at the Fort Valley and Wind River Forest Experiment Stations has thrown a flood of light upon the best methods of securing natural reproduction of western yellow pine and Douglas fir. These problems are difficult because of the dry climate and frequent droughts in the Southwest and logging slash conditions in the Northwest, and even their partial solution gives the key to scientific management of these important forest types. Such solutions, reached only through prolonged observations, experiments, and studies demonstrate the importance of permament forest experiment stations.

There is no use in growing timber to be burned; and the Forest Service is paying more and more attention to studying forest fires as well as fighting them. This study is proceeding along a variety of approaches. Where do the most fires occur? How are they caused? What are the weak spots in the prevention organizations? Such studies make possible an increased efficiency in the expenditure of fire-protection funds, public or private, and in the reduction of current fire losses.

Another promising lead is the relation between forest fires and weather. Forest Service investigators are finding a very close relation between the relative humidity of the atmosphere and the fierceness with which forest fires burn. Low humidity means danger, but abundant moisture in the air acts on a fire like a wet blanket. Tests made this season on forest fires in the Pacific Northwest have predicted with surprising accuracy the rising or falling violence of the fires and have made possible increased efficiency of attack. A great difficulty in large-scale fire fighting has come from our inability to recognize dangerous conditions until they have actually arrived and oftentimes brought disaster. The prediction of these oncoming emergencies, even a few hours ahead, will permit more effective mobilizing to meet them.

### FOREST PRODUCTS.

If it is folly to grow timber merely to be burnt, it is equal folly to grow it to be wasted by ignorance or indifference. Nowhere in American life is waste more conspicuous than in our forests and forest products. In all the stages of manufacture—the woods, the sawmill, the wood-using factories, the building trades, wherever wood is used—there is waste, appalling in its aggregate. American business has begun to see the vital importance of better methods of manufacturing and using wood; it recognizes that wood saved is equivalent to wood grown; it perceives that high prices and growing scarcity must soon make economy imperative; and it desires to be shown how waste may be curtailed. The work of the Forest Products Laboratory is accomplishing this. In a word, its task is to do by saving what silviculture does by timber-growing.

The year was one of the most successful in the history of the Forest Products Laboratory. The scope of the fundamental research was enlarged, its application increased, cooperative work with industrial agencies extended, and new methods of disseminating results developed. This involved a larger personnel than for any previous year save during the war crisis.

The annual production of lumber and structural timbers for general building purposes reaches a value of nearly a billion dollars, and its most efficient production and utilization present many problems, the study of which goes on year after year. The study of the strength of timbers is a case in point. The object sought is to reduce waste by developing more accurate knowledge of the limits and causes of strength variability, so that less allowance need be made to insure the necessary margin of safety. A series of studies completed during the year show how, with proper selection, higher working stresses and hence smaller timbers of Douglas fir, western yellow pine, and hemlock can be used than in the current practice. An exhaustive piece of research which will extend over four years is under way on large columns of southern pine and Douglas fir; it has already indicated that pieces with more knots than have been allowed can be used and that grading rules for their selection can be improved.

The laboratory is dealing on a comprehensive scale, yet with elaboration and painstaking accuracy, with the whole field of use of wood. Nor is its work confined to finding out how wood can be saved, or better used. A large part of its effort is given to bringing to pass the industrial application of results. Representatives of the laboratory have taken an active part in the movement for standardizing lumber grades. This reform is a very large task, but if rightly accomplished its value to the country can hardly be overstated.

A few examples will serve to illustrate to what extent the work of the laboratory bears upon the standardization of lumber and other forest products. During the year standard methods of mechanical tests of woods, developed through many years of work, were adopted by a committee representing the American Society for Testing Materials—the first step to its final ratification by the society and ultimately by the American Engineering Standards Committee. A committee appointed by the Secretary of Commerce to develop a general national building code also adopted the laboratory's recommendations having to do with the use of wood in buildings. A safety code for ladders, as developed by the American Engineering Standards Committee, included the laboratory's recommendations for the selection of side rails. Uniform specifications for railroad ties, formulated under the direction of two sponsors appointed by the American Engineering Standards Committee, one being the Forest Service, were tentatively adopted by a committee representing 13 national organizations.

The year marks also the conclusion of an exhaustive research initiated early in the war to determine the kinds of woods and manufacturing conditions necessary to insure efficient airplane propellers. The work has conclusively proved that aside from wearing properties, practically all commercial American woods, whether quarter or slash sawed, can, under proper manufacturing conditions, be satisfactorily used. This knowledge at the time of the war would have saved enormous expenditures for mahogany and walnut. Other results of value in connection not merely with propellers, but with all high-grade glued-wood products, were secured concerning the conditions necessary for the most effective gluing, the methods that afford best results, water-resistant glues, protection coatings to increase the resistance of glues to moisture, and the best methods of joining and splicing laminations. It was found that with proper gluing, forms of joint, and joint construction, a joint strength equal to that of the wood can be secured. All of these matters make for the more economical use of wood.

Continued attention was given to the study of boxes, crates, and fiber containers—a subject of great importance and many ramifications. Its purpose is to enable the commerce of the country to be carried with a minimum of wood consumption and a maximum of service. Approximately 16 per cent of our lumber goes into crates and boxes, while the use of fiber containers is increasing very rapidly. The failure of containers in shipment results in enormous annual losses. The general character of this study and some of its results have been outlined in previous reports. New and valuable information on the causes of weakness and how the requisite strength can be secured with more economical use of material was obtained.

Similarly, the practicability of eliminating waste in wood-using industries due to sawing full-length lumber into pieces of the size and kind desired for manufacture, instead of purchasing such pieces as "dimension stock" from the sawmill, where its production would result in a marked economy of material as well as in lower freight costs, was given much attention and found to promise enormous savings. New and important results were obtained in the study of kiln-drying methods, and a broad study of air-seasoning methods was initiated.

Microscopic studies indicated that "brashness," at least in spruce and ash, is due to incipient decay rather than to any structural characteristics, and this, if established, may lead to practical methods for its determination and elimination. Improved and cheaper methods of preservative treatment, particularly of Rocky Mountain Douglas fir ties treated with zinc chloride, were sought with success. Studies designed to prolong the life of the naval stores industry in the South through improved methods of turpentining were continued.

Substantial improvement in the chemical products and by-products of wood cellulose are dependent upon a much more exhaustive knowledge of its chemistry than now exists. Research during the year established significant facts which have a direct bearing upon the most effective selection of material for chemical by-products. The possible increase in yields under chemical pulp processes from the 40 to 45 per cent now obtained to the theoretically possible yield of 60 per cent without decided loss in the quality of the pulp depends upon a much more exhaustive knowledge of cellulose chemistry.

Investigations to improve the sulphite process developed a method of analyzing cooking liquor which permits an accurate control of the cooking time and pressure and thereby makes possible the accurate regulation of the cook and the quality of pulp desired. This method is now being tested commercially and should permit a marked improvement in the cooking of sulphite pulp. It has also shown the desirability of using water-saturated chips in the sulphite process—a radical change from the present commercial practice of using air-dried or even kiln-dried chips. Other important progress in pulp and paper investigations includes the completion of comparative pulping tests on approximately 100 commercial American woods; the development of methods for the successful grinding of jack pine for container board, which if commercially applicable will have a wide bearing on the value and future utilization of the enormous quantities of Lake States jack pine; and further work on a method for deinking of news and magazine stock, which has been partially and will be completely tested on a commercial basis.

Investigations in the production of sugar and ethyl alcohol from mill waste and sawdust showed that the yield of convertible sugars should be increased 25 per cent by stronger sulphuric acid, without appreciable increase in expense. Chemical studies of the sugars and cellulose also showed the production of mannose during the hydrolysis of wood cellulose and thereby established a marked chemical difference between cellulose from cotton and from wood, a fact heretofore denied by many authorities. The development of cattle food from hydrolyzed sawdust has progressed satisfactorily, final tests completed during the year with University of Wisconsin experts having shown that this material can be fed dairy cattle with good results to the extent of one-third of the normal concentrated food. Continued research for a higher yield of wood alcohol in the destructive distillation of hardwoods disclosed that sodium carbonate is by far the most effective of over 30 catalyzers, and gives a largely increased product. Efforts will be made during the coming year to determine its commercial applicability.

With the increasing volume of valuable information from research particular attention was directed during the year to its more effective dissemination and application. The short instructional courses in kiln drying, boxing, and crating given to industrial representatives were expanded. In order to place kiln drying results more effectively before western lumber manufacturers several members of the staff devoted over five months to kiln courses in the West. The success which marked this work indicates the desirability of further expansion of extension activities along these lines.

The publication of results is the most important means of dissemination and one which is being expanded. Never during any month of the past year did articles on the laboratory work appear in less, and in some months many more, than 100 technical, trade, and popular magazines. Each of a number of brief articles summarizing the most widely usable facts obtained from research received a wide circulation through the press at large.

## FOREST ECONOMICS.

The pressure of population on natural resources is perennial. As never before the world is taking stock of what it has and what it needs. Not the least indispensable of these things is wood, and to take stock of how much wood we have and what we shall need is an important step in determining our future attitude toward our forests.

As a background to this broad inquiry, Forest Service investigators have recently completed a unique and exhaustive compilation of the forest resources of the world. Not the least startling of its revelations is that so far as our great structural and all-purpose woods—the softwoods—are concerned, we must become self-sufficient or go without. There is an immense reservoir of hardwoods in the Tropics, hardwoods which can be used for limited and special purposes and secured at mahogany prices. But the struggle for the world's supply of softwoods will become more and more intense, and those nations will fare best that prudently use their suitable waste lands for growing coniferous woods. This study rudely shatters the dream of those who rely on importing the timber we need when our own is gone.

Nor is the situation hopeful when we turn to our own forests. There has been a marked and fairly steady decline in our national output of lumber from about 46,000,000,000 board feet in 1906 to less than 34,000,000,000 board feet in 1920. This downward trend, which seems unlikely to turn permanently upward again at any time that can now be foreseen has taken place in spite of a large increase in population, with its increasing demand for housing, furniture, and wood in many other forms. The decline in the production of lumber and the increase in population have resulted in a striking drop in the per capita consumption of lumber—from over 500 board feet per person in 1906 to about 320 board feet in 1920.

Unquestionably among a people who have largely depended on wood for so many of the essentials of industry and daily living, as well as for the comforts and luxuries of an expanding civilization, this decline in the consumption of wood means a decline in the standards of living. Of this declining standard the shortage of housing is an impressive example.

The shortage of lumber, with its corollary of high prices, has followed the westward sweep of lumbering, while the bulk of our population and the greatest demands for lumber remain in the Central and Eastern States. The Nation's lumber shipment in 1920, a recent Forest Service study shows, was no less than 2,070,000 carloads; and the average haul for each carload was 485 miles. According to the best estimate the Forest Service is able to make, the freight bill on lumber for that year was $275,000,000. This gigantic sum merely gives one measure of the cost of treating our forests as mines instead of timber farms. A fraction of this sum wisely invested each year in forest protection and rehabilitation would grow timber where it is needed, reduce the Nation's freight bill, cheapen lumber, and release vast amounts of railroad equipment and labor for unavoidable transport. Coal and iron can not be grown, but timber can be.

These are some of the broad-scale effects of forest depletion. To trace its effects more minutely in one typical region, the branch of research is conducting a study of the economic effects of forest devastation in one State. What does forest destruction do to population, to agriculture, to labor, to the lumbering industry, to the wood-using industries, to the general economic and social life of the community? Here, in one cross section of American life, answers to these questions will be sought in order to strike a balance sheet between forest devastation and forest conservation.

On a nation-wide scale also, though less intensively, the research corps is tracing out the effects of timber mining as opposed to timber growing. This study will attempt not merely to set forth the historical, economic, and social consequences of timber mining, but to make a census of our total progress in forestry up to the present time. This, it is hoped, will be a useful contribution to the general study of the use of land now being made by the Department of Agriculture. In its larger aspects forestry is not merely a land problem, but an agricultural problem. Not only should lands best suited to forests be used for forests, but these forests should be intensively managed as farms are intensively managed. For a stable and prosperous agriculture in many older regions of the East, the forested hills and the cultivated valleys must be handled with equal skill; they are indispensable one to the other. Luckless attempts to convert good forests into poor farms are fortunately on the wane.

Unfortunately financial limitations do not permit a stock-taking of our forests on an adequate scale. Yet these studies point the way and show the urgency of a nation-wide timber survey, a project the Forest Service has strongly urged in recent years and again repeats.

## GRAZING STUDIES.

Efficient use of range land is dependent upon intensive investigations. The results so far secured in the administration of national forest ranges are partially attributable to the investigations conducted at the Great Basin Experiment Station in Utah and at the Jornada and Santa Rita range reserves in New Mexico and Arizona. As these experiments are extended and perfected, the need for more knowledge of the effect of grazing on the life of valuable forage plants becomes apparent. While in the nature of the case a long interval must elapse before the results of investigations are fully available for use, they are applicable to both private and Government land, and are becoming an essential part of the everyday grazing practice.

Intensive reconnaissance or stock taking by grazing specialists during the year covered a total of 1,024,921 acres on the Beaverhead, Montezuma, Carson, Santa Fe, Fillmore, and Wasatch National Forests. In addition, 573,101 acres were covered by local forest officers. Reconnaissance of national forest ranges is now progressing at the rate of less than 2,000,000 acres a year. It should be largely expanded, since it is the essential basis, the inventory of forest resources, upon which all betterments in grazing management depend.

The trained grazing experts in the Forest Service have proved invaluable not only in conducting range reconnaissance and preparing grazing management plans for national forests, but particularly in bringing the current use of the range into line with the new requirements. A much larger number of technically trained grazing men is needed to get the improved methods of range management developed by research into effect on the national forest ranges.

Artificial reseeding was studied principally at the Great Basin station and the Jornada Range Reserve. At the Great Basin station it was found that introduced species, such as timothy and redtop, do not produce viable seed at 8,000 feet elevation or above, so that the planted stands disappear and reseeding becomes necessary at intervals of five to seven years. The sod-forming grasses, such as Hungarian brome, Canadian blue grass, and others, spreading as they do by underground shoots, will increase naturally from an original seeding. The evidence points to the undesirability of using seed-dependent plants as against the true sod formers in artificial reseeding of the range. Artificial reseeding has in no way shown itself as a substitute for range management that will secure natural revegetation except on especially suitable sites where there is little hope for the restoration of native vegetation in the near future.

Natural revegetation studies were continued at the Great Basin station and at the two range reserves. On several forests in each of the districts areas protected by inclosures have been established to enable administrative officers and stockmen to see by comparison how use of the range as currently practiced is affecting the vegetation. These plots are of material importance in determining the need for improving the forage production and in convincing stockmen of the necessity for methods of management that will permit revegetation.

Critical studies of the effect of time and frequency of cropping upon vegetation were continued at the Great Basin Experiment Station. The results so far obtained indicate that too early grazing is the leading factor responsible for the present run-down condition of many ranges, but that if grazing is deferred until the main forage plants have reached a height of 6 inches, there will be little or no injury from this source if the land is not too heavily grazed. Observations were made on many forests to determine where grazing of the various parts of the range should begin, and management methods were devised to control the movement of cattle to conform with the various seasonal and altitudinal zones, by proper salting, herding, and fencing. Postponed opening of the season compels range users to hold stock on the winter range or feed them longer; but the evident benefit to the forest ranges of postponement has made stockmen willing for the most part to make the adjustments necessary.

The collection of range plants and the study of their distribution, forage value, and life history was given considerable impetus by the general range appraisal which has been undertaken. Original identifications were made of 2,801 specimens by the Bureau of Plant Industry in 1921. The collection now contains about 43,500 specimens, of 5,168 species and 110 varieties, belonging to over 1,000 genera.

The study of the effect of grazing on erosion on alpine lands emphasized the necessity for preventing any grazing practice which causes destruction of cover, or the retarding of a permanent, dense vegetation. Where erosion has already begun, the planting of sweet sage, violet wheat grass, and mountain and smooth brome grasses has been found a promising measure for checking it, but the treatment necessary is justified only on watersheds of special importance for furnishing water for municipal or similar purposes.

The study to determine the effect of burning dense brush areas in California on their value for grazing was concluded. It has shown that after a temporary increase in the carrying capacity of the range, due to an increase in herbaceous vegetation and in tender browse sprouts, the brush crowds out the herbaceous plants and the sprouts become too woody to be browsed. The danger of fire spreading from brush areas to valuable timber stands, the cost of burning, and the short duration of its good effect argue against this practice.

Drought conditions in the Southwest, coupled with the difficult financial situation, handicapped the investigation of methods of handling stock on the Jornada Range Reserve. Nevertheless, the methods being tried out showed their superiority over those commonly used in the Southwest. On both the Jornada and the Santa Rita Range Reserves losses last year were much less and calf crops larger than on adjoining similar range. To make the Jornada investigations fully effective in securing results of great importance to stock growers in dry regions, provision should be made for the purchase of a herd of cattle sufficient in size to meet the need of the experiment. Such a purchase would permit cooperation between the Forest Service and the Bureau of Animal Industry in determining in connection with the use of range land the breeds and methods of management best fitted to the requirements of the most important breeding section of the West, the age at which stock can most profitably be disposed of, and many kindred problems essential to the betterment of the industry. A salting study under way in New Mexico and Arizona will determine whether cattle can be salted advantageously away from water in a dry climate.

Determination of grazing capacity is one of the most important and complicated problems in range management. It involves more or less study of each individual range because of differences in the natural forage cover, factors affecting its use, and climate. The recurring droughts in the Southwest emphasize the need for taking the factor of drought into consideration in determining the carrying capacity of ranges.

The practicability of eradicating tall larkspur by grubbing has been fully established, and all that remains is to prosecute this work on larkspur-infested ranges wherever funds can be secured. No

Government funds were available for this purpose, but stockmen did considerable grubbing of forest ranges at their own expense. The Government should undertake a large number of projects, in the interest of increased grazing receipts and decreased fire hazard, on areas now ungrazed. Eradication of water hemlock by grubbing was tried out on several areas in the Northwest with fair success and saving of live stock. Grubbing of loco in the Southwest gave only indifferent results. The original stand was usually eradicated, but the plants are prolific seeders and seeds appear to lie dormant for one or more years, so that reinfestations occur with the recurrence of favorable growing conditions.

Valuable data were collected on watering places on various ranges in the Southwest. The object was to obtain a basis for a water-development policy. Efficient watering is one of the major problems of range use in the desert regions. This was especially manifest during the drought in the Southwest the past year, when many stock died because of the long distances they had to travel to water when they were in poor condition and feed was short. Severe depletion of the range around watering places also took place.

Studies were started on the Tonto Forest in Arizona and on the Dixie-Sevier Forest in Utah to work out the proper management for browse range. The studies have shown that the degree of grazing necessary to secure full use of the browse is detrimental to the herbaceous vegetation and increases erosion.

A study to determine the best grazing management for the vast areas of logged-over lands west of the Cascades in the Northwest was started. Its object is to formulate a grazing practice which will insure for logged-over lands in that region adequate reforestation, reduction of fire hazard, and profitable returns from grazing. It is believed that another stand of timber and a reduction of the fire hazard can be obtained, together with cash returns to help pay carrying charges, provided use for grazing and for timber production are properly harmonized.

## INFORMATIONAL AND EDUCATIONAL ACTIVITIES.

Increased attention was given by forest officers to methods of securing the cooperation of the public in fire control, and particularly in fire prevention through the exercise of habitual care in the woods. The reduction of fire loss and expenditures for protection is a problem affecting human conduct. Passive approval by the public of the idea of protecting forests against fire is far from being enough. Carelessness with fire is primarily a matter of personal habits, and to change the habits of a large number of people so that they will not merely agree that fires are undesirable, but actually govern their conduct in accordance with a conviction of a public duty in the matter is not an easy or simple task. In the language of the street, it is the task of "selling" forest protection to the American public.

In so far as the local public in and about the national forests is concerned, to a very large measure this task has already been accomplished. The extent to which a sense of personal responsibility in the use of fire in the open has taken hold of communities in these regions is really surprising. It is partly the result of appreciation of the actual benefits of the forests as contributors to individual and local welfare. It is, of course, also partly the educational effect on public sentiment of the mere organization of protective activities by the Government—of the fact that fires are fought—not allowed to run their course as though they were a part of the natural order of things. But it is also, and in large measure, the result of conscientious educational effort directed at the evil of man-caused fires and seeking to strike at the root of that evil by, first, making men unwilling to cause fires, and, secondly, showing them what they should do or not do in order to avoid causing fires.

There is still much more that needs to be done even among the residents within and near the forests. Community education to the habitual and thorough-going practice of fire prevention requires constant reiteration of the lesson to be inculcated, and constant study of new ways to bring it home. This is being sought. Forest officers are encouraged and expected to give thought and time to it as a part of their official duty. Not only through personal influence exerted in their daily contact with forest users and their fellow citizens but through public talks, when occasion offers, before civic bodies, commercial organizations, social clubs, schools, and similar gatherings, through the press, through participation in and encouragement of forest-protection week, through effective use of posters and other educational material furnished them for distribution, and through ingenuity in devising new methods of arousing the interest of the public in the subject of fire prevention and what it requires of the individual, they are actively spreading the gospel of forest protection.

But there is urgent need for a much broader work of public education against forest fires. As facilities for travel into and through the forests are multiplied and as resort to the forests for recreational purposes increases by leaps and bounds, it is necessary to find ways of inculcating habits of care and a realization of the importance of preserving the forests on a very broad scale. A large part of the danger to the national forests from man-caused fires is due to the seasonal influx of tourists, campers, hunters, and fishermen, and other visitors from the cities and from distant parts of the country. A national campaign of public education on the subject of forest fires is demanded if the task of protection of the vast area of the national forests, from Maine and Florida to California and Washington, is to be successfully performed.

There is a greater reason for conducting such a campaign with vigor and effectiveness. The interests of the public in forestry are not confined to the perpetuation of forest growth and the saving from fire of the present growth of timber on the national forests. All forest lands, whether publicly or privately owned, must be protected if the needs of the Nation are to be met. They can not effectively be protected without the general cooperation of the public to prevent fires as well as specific provision for detecting and suppressing fires as an organized activity.

Even this is not all. The people of the United States are becoming alive to the need for forestry, but they are far from realizing what it actually calls for. Forestry is with us largely a governmental activity alone, an educational development working downward from the top, not a common possession of the rural population. It needs to become ingrained in the lives and habits and modes of thinking of the people—to become, as it is with the French people, almost instinctive. It needs to become a part of our farm lore, on the same footing as the growing of corn or potatoes or wheat or the care of orchards and live stock. We are so far from this that in many parts of the country intelligent people still regard forestry as synonymous with tree planting, and suppose that the way to go about it is by requiring that whenever a tree is cut down another should be put in its place. Under such conditions the right use of forests generally is hopeless.

To promote the diffusion of knowledge of forestry generally, as well as to secure the best results in the efforts of all parts of the Forest Service to bring about better protection of the national forests, the branch of public relations was created a little more than two years ago. Its work includes informational and educational activities in the Washington office, including the preparation of news material, exhibit and motion-picture plans, and cooperation with educational agencies of many kinds. It includes also the conduct of similar activities in all the district offices and by forest officers on the national forests. While it has obtained important results it has not begun to take full advantage of the numberless opportunities to advance forestry throughout the country through the work of public education. It is not engaged in propaganda to build up support for the Forest Service as an organization or for specific policies or measures concerning the advisability of which there may be question, but exists for the diffusion of knowledge without which enlightened action is impossible. Its work should be largely extended.

# REPORT OF THE CHEMIST.

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United States Department of Agriculture,
Bureau of Chemistry.
*Washington, D. C., September 16, 1922.*

Sir: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1922, and recommend that it be printed in the usual manner.

Respectfully,

W. G. Campbell, *Acting Chief.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

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## INTRODUCTION.

The activities of the Bureau of Chemistry may be classified for easy consideration into three broad groups which, although fairly well defined, are so closely correlated in some instances that there is no distinct line of demarcation, but rather a merging or supplementing of the activities in the one group by those in the other two. These three groups may be designated (1) research in agricultural chemistry; (2) the application of chemistry to production and the utilization of agricultural products—that is, agricultural chemical technology; (3) the enforcement of certain regulatory statutes which frequently either gives form to the results obtained in the other two groups or influences the activities of those groups by revealing problems which it is their function to solve.

The fiscal year 1922 has been one of stock taking and realignment of certain activities, especially in Groups 1 and 2, one of those occasional but exceedingly important readjustment periods which come in the life of every healthy, progressive organization when the evidence obtained from preliminary work in a particular field indicates the probability of obtaining immediate worth-while results so clearly as to dictate an administrative policy of concentration of effort and even a brigading of otherwise independent units to accomplish the desired results. However, where funds are limited this must of necessity curtail activities in some already established lines of work or postpone active consideration of contemplated, and perhaps equally as important, lines of work.

In Group 3 the fiscal year 1922 marked the complete installation of a system for handling the work in connection with the enforcement of the Federal food and drugs act on a project basis, which enables all units of the organization to work in unison toward a common end with the minimum expenditure of time and funds.

## RESEARCHES IN AGRICULTURAL CHEMISTRY.

The application of chemistry to agriculture in the most comprehensive sense has been one of the chief functions of the Bureau of Chemistry since its establishment, although in recent years this phase of the work has received less public attention than the work on the enforcement of the food and drugs act. The food work, however, is an outgrowth of investigations into the composition of foods conducted originally as a chemical agricultural study. While the practical application of the results of research is not always apparent for a considerable period after the researches are completed, the basic studies in agricultural chemistry have led to results of the greatest practical importance. Processes for the greater utilization of farm crops and production by-products have been developed and improved and new manufacturing industries established, work more fully outlined in another part of this report.

### ODOROUS CONSTITUENTS OF FRUITS.

Investigations pertaining to the odorous constituents of certain fruits, particularly the apple and the peach, are in progress. A paper on the odorous constituents of the peach was published during the year. A patent for the preparation of a synthetic apple oil has been granted as the result of these researches. A paper describing the results of a further investigation on the apple odor has been prepared for publication, and also one on the presence of methylanthranilate in grape juices.

### STUDIES ON VEGETABLE OILS.

The economic importance of a further utilization of vegetable oils and of the production of oils from sources not now available has led the bureau to make a systematic study of the chemical composition of vegetable oils. These studies include investigations to determine the physical and chemical characteristics of the principal commercial vegetable oils, especially those produced from oil seeds grown in this country. The chief vegetable oils manufactured in the United States include castor, coconut, corn, cotton seed, linseed, mustard seed, olive, palm kernel, peanut, raisin seed, rapeseed, sesame, and soy bean.

During the year investigations on the composition of sunflower-seed oil and soya-bean oil have been completed and the results prepared for publication. Work on the determination and identification of the constituents of crude cottonseed oil is under way. Considerable progress has been made in the separation of the free fatty acids occurring in the commercial crude cottonseed oil, and a study is being made of the composition of these acids, as no data are available which give this information needed by the oil industry. Work on the method for determining the total amount of neutral glycerides in a crude vegetable oil has been completed and the results published. This is the first time in the history of the great cottonseed industry that a method has, upon investigation, been found applicable to determine the neutral oil present in a crude vegetable oil. Researches of this character, which will show how to reduce the refining loss, are of indirect benefit to the cotton growers, since the price paid by the refiner for crude oil may be greater.

Results of analyses of authentic peanut oils were published during the year.

Past results from research conducted elsewhere on cottonseed oil, making it possible to utilize profitably cotton seed, which was considered until comparatively recently practically a waste, indicate the possibilities of further research on vegetable oils.

### STOCK FOOD INVESTIGATIONS.

Investigations are in progress on the utilization of waste products as cattle feeds. A bulletin has been prepared upon the use of apple pomace and apple pectin pulp. The work on this subject involved a large number of laboratory determinations and large-scale feeding tests of the pulp, in cooperation with the Bureau of Animal Industry experiment station at Beltsville, Md.

To help other bureaus of the department solve problems in which the composition of cattle feeds and grains is a factor, many analyses are made of samples submitted and the results reported to them. During the year 158 samples were examined for the Bureau of Markets and Crop Estimates, 1 for the States Relations Service, 72 for the Bureau of Plant Industry, 19 for the Bureau of Animal Industry, and 81 for the Forest Service. In addition, 2 were examined for the War Department and 31 for the Panama Canal Commission. These analyses are of great value in establishing specifications and controlling purchases.

A study has been made of the various portions of the kernels of grain sorghums in order to determine the suitability of grain sorghums for feed and for milling purposes. The results are reported in a bulletin in course of publication on the composition of feterita and milo.

In cooperation with the Bureau of Markets and Crop Estimates, a study was completed on cotton seed and its products, the object being to determine the quality of cotton seed in different sections of the country as a basis for practical standards and for a better understanding of the composition of cotton seed as affected by the locality in which it is grown and the variation in composition during the season. The results are given in Department Bulletin No. 948, entitled "Composition of Cotton Seed," which was published during the year.

### CROP CHEMISTRY INVESTIGATIONS.

A laboratory of crop chemistry has been recently established in order to systematize and extend the work in this most important agricultural field. Studies will be undertaken on the composition of agricultural crops in a fundamental way. Steps are being taken to collect, critically digest, and summarize existing data in order that gaps may be filled in our knowledge thus brought to light. Additional work will be carried on concerning the influence of environment on the chemical composition of crops, including certain features of fertilization, such as the relation of chemical composition and food value of crops to the time of fertilizer application.

Past work on the composition of agricultural crops has been directed chiefly toward what may be termed the quantity viewpoint. This new work will be directed more toward the subject of quality. For instance, it is known that the application of a certain fertilizer, say, sodium nitrate, at a definite time, as one month after sowing, to a crop like corn will increase the yield quantitatively. However, practically nothing is known about quality relations; that is, whether the proteins, vitamines, or mineral components of the corn fertilized in such a way are better suited to animal and human nutrition than those of unfertilized corn. Varietal differences will be studied from a chemical viewpoint. For instance, it will be determined if there are any fundamental chemical differences in the composition of flint or hard corn and the dent corn largely produced in the United States, in an endeavor to determine the reason for the preference of the European countries for Argentine or flint corn to corn produced in the United States.

## PROTEIN INVESTIGATIONS.

One of the most important researches now under way is that upon vegetable proteins. Inasmuch as nitrogen is an essential part of animal tissues and the animal can obtain this necessary nitrogen only in the form of protein in its feed, it is obvious that this class of feeds is of prime importance. This research involves the very existence of all animals and is inseparably connected with the field of nutrition.

Until quite recently one kind of protein in a diet was considered as good as another. To-day we know that one protein differs from another protein in certain fundamental constituents called amino acids, of which all proteins are composed. Some of the amino acids are absolutely essential for nutrition, for without them animals will not grow, but will soon fail and die. The protein of corn is deficient in two essential amino acids, tryptophane and lysine. A young animal on a diet having its sole source of protein derived from whole corn will not grow and develop properly. However, if the protein of corn is supplemented by the addition in the right proportion of certain other proteins, the protein of the mixture will then be adequate for normal growth. From this it follows that an exact knowledge of the chemical composition of the different proteins in feeds is necessary. It is essential not only to know whether in themselves they are adequate for the needs of the animal but also to know when they are deficient, what other proteins, and in what proportion, must be added to supplement the deficiency. The percentage of nitrogen alone can not therefore any longer be regarded as an index of the protein value of a feeding stuff.

The amino acids of the proteins of several agricultural products have been separated and studied, with the result that it is now possible to supplement such basic feeding stuffs as corn with small quantities of other feeds, such as peanut meal, soy-bean meal, and coconut press cake, which contain the very amino acids corn lacks, thus making a feed that will supply all the amino acids necessary for growth. The practical results of this should be a greater and more profitable utilization of our largest cereal crop, corn.

Work now in progress includes an investigation of the protein of wheat bran. A method by which over 90 per cent of the total protein present in bran may be extracted has been developed and applied. Analyses of these proteins have shown that they are probably of high nutritional quality. The extent to which the protein of bran differs from those of the wheat endosperm will be ascertained.

An investigation of the protein of cotton seed is in progress. Little work has ever been done on this subject, notwithstanding the large and continually increasing extent to which it is used as a feed for farm animals. Since most of the peanut meal offered on the market for feedstuff contains also the shells, it is desirable to have some knowledge regarding the protein in the shells, and studies to this end are under way. A chemical study of the protein of cantaloupe seed is nearing completion. Work on the determination of the amino acids in soy-bean globulins is being continued.

Studies of the nutritive value of the palm-kernel meal were completed. The results show that the proteins of palm-kernel meal are adequate for the promotion of normal growth.

Work on the nutritive value of the proteins of the lentil is in progress. Results of work on the protein of the cowpea and of the field pea have been published during the year. The proteins of the cowpea are limited in their nutritive value by a deficiency of the amino acid cystine, and by an indigestibility which can be remedied by cooking. The protein of the field pea, and that of the cooked cowpea, plus cystine, were equally efficient in promoting growth at a practically normal rate, while the protein of the cowpea, raw with cystine added, or cooked without cystine, was less than half as well utilized as those of the field pea.

Results of research on the protein of the tomato seed have been published. Over 2,000 tons of tomato seed are annually discarded as a by-product in the tomato-pulping industry. These studies show that by utilization of this by-product for feeding purposes the conservation of a valuable feed can be accomplished. A chemical study of the protein of the lima bean has been completed. Chemically and also biologically the protein of the lima bean is quite similar to that of other beans which are botanically related. They contain adequate amounts of the nutritionally essential amino acids with the exception of cystine, the percentage of which is below the minimum required for the normal growth of animals.

A chemical study of the protein from the navy bean has been completed and a manuscript prepared for publication. A manuscript is being prepared on "The nutritive value of peanut, soy bean, and coconut press cake as supplements to corn." Studies on the proteins of other beans are in progress.

## WORK ON INSECTICIDES AND FUNGICIDES.

Studies are being made of the chemical composition and efficiency as a fungicide of Pickering Bordeaux mixture to ascertain whether Pickering formulas can be applied under American field conditions so as to accomplish effective control of fungi diseases. The ultimate object of the study is to use Pickering Bordeaux instead of standard Bordeaux if it is possible, since Pickering Bordeaux contains much less copper than standard Bordeaux and is, therefore, very much cheaper. Experiments in northern Maine indicate that Pickering sprays exert the same stimulating action on potato plants and increase in yield to the same extent as standard Bordeaux sprays. A barium copper spray was prepared which possessed some very desirable properties as a fungicide and gave satisfactory results on potatoes. A public patent covering the preparation and use of this product has been obtained.

As a result of investigations of the problems involved in spraying potatoes and other plants with Pickering and other copper sprays, papers were prepared during the year on "Absorption of copper from the soil by potato plants" and on "The influence of copper sprays on the yield and composition of the tuber of the Irish potato."

Chemical and physical studies of insecticides and investigations on the physiological effect on insects of arsenical insecticides and of the materials entering into their composition have been carried on for the past four years in cooperation with the Bureau of Entomology. Some of these results will soon appear in bulletin form under the title "Arsenicals: Chemical, physical, and insecticidal properties."

Investigations in cooperation with the Bureau of Entomology have been carried on in Texas for the purpose of devising methods for the control of screw worm flies and related species which infest live stock, particularly cattle. Several attractants have been discovered, of which dried eggs seem to be the most promising These when used in connection with traps have been found to be of great value in reducing the number of flies. Several promising repellents have also been found and are being further tested.

An investigation was made to determine the quantity of poisonous elements that may be present on sprayed fruits and vegetables by reason of the excessive use of sprays, and to determine whether changes can be made in the time and method of spraying by which the danger from injurious metals may be eliminated. The results were published in Department Bulletin No. 1027, Poisonous Metals on Sprayed Fruits and Vegetables.

The results of hundreds of fumigations of various grains, vegetables, and other food products with hydrocyanic acid for the purpose of destroying insect pests infesting them are embodied in a manuscript prepared under the title "The absorption of hydrocyanic acid by fumigated food products."

Foliage injury by lead arsenate and other insecticides was studied to determine the action of various impurities in lead arsenate on foliage, and the action of natural water containing various salts on lead arsenate. Investigation was made of the burning properties of various insecticides and fungicides and an effort was made to develop spray materials and mixtures effective as insecticides and fungicides but producing a minimum injury to tender foliage.

Cooperating with the Bureau of Entomology on methods for the control of the Mexican bean beetle in Alabama, a number of lead arsenates and other arsenicals were prepared for trial. The bean plant is particularly susceptible to injury from the application of arsenicals. A satisfactory poison that can be used with safety on bean foliage has not yet been developed. It was found that the natural waters in certain regions act on lead arsenate, breaking it up and forming soluble compounds that are injurious to the foliage. A number of the waters were analyzed and methods for overcoming this objection were suggested.

Several special calcium arsenates and four nicotine dusting mixtures were prepared for tests on cotton foliage. During the year 1,202 samples were examined to aid other bureaus of the department, especially the Bureaus of Entomology and Plant Industry, in solving problems which required chemical investigations of an insecticidal or fungicidal nature.

Cooperative work with the Bureau of Entomology has been started to make a thorough chemical and physical study of calcium arsenate for the purpose of developing a more satisfactory calcium arsenate for use as a dust application to cotton for the control of the boll weevil.

### METHODS OF ANALYSIS.

A portion of the time of the chemists of the bureau was devoted to the development of new and the improvement of old methods of chemical analysis. These methods are published from time to time as they are perfected in the Journal of the Association of Official Agricultural Chemists or in other scientific journals for the use of chemists employed in the agricultural experiment stations and in the industries. The development of methods of analysis is to the chemist what the building of improved roads is to the traveler, enabling him to enter new fields more easily, rapidly, and efficiently. Results obtained in different investigations in widely separated fields of activity are comparable only when standardized methods have been used.

Agricultural chemists in the experiment stations and colleges cooperate in the development of methods of analysis. While the immediate results of this work are of interest only to chemists, the ultimate results are reflected in an improved agriculture and in the development or improvement of industrial processes for the utilization of agricultural products.

## AGRICULTURAL CHEMICAL TECHNOLOGY.

As a natural outgrowth of the research work in agricultural chemistry, there are in progress a number of projects which have for their primary object the development of manufacturing processes which utilize and provide new outlets for the products and by-products of the farm. This is the practical application of the results of research.

### IMPROVEMENTS IN THE MANUFACTURE OF CANE SIRUP.

Marked progress was made during the year in putting into commercial practice the invertase method of making cane sirup to which reference has been made in previous reports. Several cane-sirup makers used the new process during the last season with excellent results. A cane sirup which would not readily crystallize or ferment was for the first time placed upon the market in considerable quantities.

Attention is now being given to the production of a cane sirup of uniform standard quality. This work promises to be of the greatest economic importance to the cane-producing States.

A more extensive market for cane sirup is of great importance in the agricultural scheme of a large area of the South. In many sections cotton can no longer be profitably produced on account of ravages of the boll weevil. It is necessary to adopt a more diversified scheme of agriculture, and sugar cane is one of the crops upon which greater reliance should be placed. It is one of the surest crops which can be grown in this region. The harvesting and production of cane sirup come at a time of the year when the farm labor can be used very advantageously for that purpose. There is ample evidence that the farmers of the South are greatly desirous of increasing their acreage of sugar cane. This is not possible, however, unless a more adequate market is developed for cane sirup. This market can not be extended unless cane sirup of uniform and satisfactory grade can be consistently produced. This, in turn, depends upon the successful working out of certain chemical and technological problems. These problems are therefore the key to the entire situation.

It is planned under this project to continue the work started last year and to study systematically all factors which are involved in the production of high-grade cane sirup of uniform quality and to work out all corrective measures which it is necessary to apply to present practice in order to accomplish this end.

Outside of Louisiana, sugar cane is grown solely for production of cane sirup. This is the sole manner of utilization, since the sirup is not of sufficient purity to be utilized in the manufacture of sugar. The value of sugar cane as an agricultural crop is, therefore, dependent solely upon an adequate market for cane sirup. Extension of the market beyond a local one has been greatly handicapped by the fact that cane sirup as produced by a large number of farmers has varied greatly in quality. The planters need technological assistance and advice in solving this problem.

During the past year the Bureau of Chemistry has received a large number of insistent requests for assistance along this line. The farm bureau federations in various Southern States have organized cooperative cane-sirup associations for the purpose of blending cane sirup on a large scale in central rehandling and canning plants. The bureau has been asked to undertake the solution of chemical and technological problems involved in this plan of operation and work is now under way. These cooperative associations are planning to use the invertase method developed in the bureau for the purpose of producing a sirup which will not crystallize. These associations have also requested that the bureau undertake systematic research work for the purpose of solving all remaining difficulties which stand in the way of producing a uniform cane sirup of highest grade. While a great deal of progress has been made, a number of important points still remain to be worked out on a satisfactory basis. Among these may be mentioned the best manner of treating low-grade sirup, improved method of clarification so as to secure a brilliantly clear sirup free from sediment, use of mechanical filtration, and introduction of vacuum-pan evaporation. In other words, improved larger scale methods for handling cane sirup have now become possible through the organization of the cooperative cane sirup associations and the operation of central blending plants.

### WORK ON SORGHUM SIRUP.

The situation with respect to sorghum sirup is much the same as that of cane sirup, with the exception that cooperative handling and marketing of sorghum sirup have not yet reached so advanced a stage. In the meantime it is desired during the fiscal year 1924 to discover the cause of and find a remedy for "jellied" sorghum sirup. This refers to a gelatinous consistency which sorghum sirup frequently assumes and which causes considerable loss. An improved method of clarification to secure a brilliantly clear sirup is greatly needed in order to increase the marketing possibilities of sorghum sirup, and work is planned to accomplish this. Some difficulty is also experienced from sugaring, and it is planned, when necessary, to apply to sorghum sirup the invertase method originally devised by the Bureau of Chemistry for treatment of cane sirup.

### USE OF INVERTASE IN PRODUCTS OTHER THAN CANE SIRUP.

The invertase method was applied during the year to products other than cane sirup. Application has been made for a public patent for its use in a process for the manufacture of a mixture of refiner's sirup and a partially inverted sucrose sirup. The process has been used successfully on a large scale. The invertase process has also been used in the manufacture of a high-density maple sirup and of maple and cane sugar sirup mixtures. Application for a public-service patent to cover this process has been made.

A process was also worked out for preparing a soft cream center, such as is used in chocolate creams and similar types of confectionery. This achieves a result which has for a long time been desired by the candy industry, since the process previously used was not satisfactory. A public-service patent has been applied for to cover the production of an improved maple cream by the use of invertase.

### DOMESTIC CANE SUGAR INDUSTRY.

In order to compete with cane sugar from the Tropics, the sugar-cane planters of Louisiana are very greatly in need of improved methods whereby better grades of sugar and molasses can be produced and manufactured more efficiently. Work to this end has been carried on during the past year. Research work along these lines is necessary because sugar cane does not fully mature in Louisiana, so that, since the composition of the juice differs from that of cane grown in the Tropics, special methods of manufacture must be used. The working out of more efficient methods would result in an enormous increase in the value of sugar cane and would be of the greatest constructive assistance to Louisiana cane planters. At the present time the production of sufficiently high-grade molasses is accomplished at the expense of too great a reduction in yield of sugar. The production both of an adequate yield of high-quality sugar and of molasses of acceptable grade is necessary in order to insure a reasonable return for sugar cane.

In addition to developing improved and more economical methods for manufacturing better quality molasses, the problem of utilizing blackstrap molasses most efficiently has been considered. At the present time blackstrap is virtually a waste product, and an increased return for this material would give the cane planter a corresponding profit on his cane delivered at the mill.

### BEET-SUGAR INVESTIGATIONS.

The proportion of sugar which can be extracted from sugar beets, as well as the actual sugar content, determines the value of beets to the grower and to the sugar factory. The proportion of sugar originally in the beet which is lost in manufacture results in an enormous loss annually to the beet-sugar industry. A constructive investigation of the factors which determine the proportion of recoverable sugar is just as important to the grower of beets as investigations designed to increase beet production.

Some of these factors which are distinctly chemical in character exert their influence before harvesting while others have an effect after harvesting. One of the most important is that involved in the storage of beets. Outside of California it is necessary, because of the early advent of freezing weather, to store beets in piles for a certain period before working them through the factory. This period averages about 25 days. During storage an average of 0.4 per cent of the sugar in the beets is destroyed daily, or a total of about 10 per cent of all the sugar contained in the beets at the time of harvesting.

In addition, among other factors the deteriorative changes which beets undergo during storage cause the introduction into the juice of substances which interfere with crystallization of sugar and reduce the proportion of the remaining sugar finally extracted in the factory. This effect is particularly apparent in the operation of the Steffen process, which is used in this country to desugarize molasses. If this process were as effective elsewhere as it frequently is in California, approximately 95 per cent of the sugar in beet molasses would be recovered, thus greatly increasing the total yield of sugar from beets. Owing to the accumulation of substances which interfere with crystallization of sugar, only about 60 per cent of the sugar in beet molasses produced outside of California is finally extracted. This immense wastage of sugar involves a financial loss to the beet-sugar industry of many millions of dollars per annum.

The cause of this difficulty has been ascertained, as the result of investigations in the bureau, and two methods are being proposed for a practical solution, one depending on corrective measures in the factory and the other on prevention before the beets enter the factory. The entire problem is one of applied agricultural chemistry. In view of the fact that this loss of sugar occurs after the expense for raising and harvesting the crop has been incurred, a reduction in this loss would increase the value of the beets to grower and sugar factory alike and would be of more value to the industry than a corresponding increase in beet production.

The beet-sugar industry occupies an important place in the agricultural scheme of a large area of the United States, and reduction of the sugar losses under discussion is of immense importance to it.

The industry is in a depressed condition at the present time and in certain sections of the country this condition is especially serious. Constructive assistance in the manner outlined would be of very great importance at any time and is particularly needed under present conditions.

### FURFURAL FROM CORNCOBS AND OTHER WASTE.

The work on the utilization of corncobs, which has been reported previously, has led to further experimentation in the manufacture and utilization of furfural. Heretofore the cost of furfural was too great to permit its general commercial use. It can now be made from corncobs by processes developed in the Bureau of Chemistry at a price that makes its use of interest to a number of manufacturing industries. It can be used, for instance, in the manufacture of synthetic resins which heretofore have been made chiefly from formaldehyde and phenol. The commercial demand for synthetic resin compounds is increasing rapidly, as they are used in the manufacture of printing plates, phonograph records, varnishes, pipe stems, electrical-instrument parts, buttons, binders for brushes, glue, and many other useful articles. In addition to furfural, there have been obtained from corncobs acetic acid and a gummy material which can be used as an adhesive in the manufacture of pasteboard boxes and may prove useful in the manufacture of coal briquettes.

Experiments are under way on the manufacture of furfural from other agricultural wastes, such as rice hulls, buckwheat hulls, cottonseed hulls, and peanut hulls. Peanut hulls yield less than one-third the amount of furfural that would be expected from a comparison of their pentosan content with that of corncobs. The yield with steam alone is so low as to preclude any commercial consideration of the use of peanut hulls as a source of furfural by the process as used for corncobs. There are indications that this yield may be considerably increased by the use of certain catalysts, and the effect of these will be studied.

### BEVERAGE FROM CASSINA.

Investigations on a laboratory scale showed that a very delightful beverage resembling tea in many respects can be made from cassina, a wild plant that grows abundantly in the South Atlantic and Gulf States from Virginia to Texas, when the leaves of the plant are treated by processes similar to those used in curing tea. The cassina plant has been used to a limited extent by Indians, and, during the Civil War when tea and coffee could not be obtained, by people of the Southern States, to make a beverage. Unless properly cured, however, cassina does not make a good beverage.

It having been demonstrated in the laboratory that cassina could be treated by processes similar to those used in the tea industry and an excellent beverage made from it, work has been undertaken to produce it on a larger scale. An experimental plant has been installed near Charleston, S. C., and preliminary reports indicate that the laboratory results can be duplicated on a commercial scale.

Laboratory experiments have been conducted on the use of the hot water extract of properly cured cassina leaves as a base in the production of carbonated beverages. Carbonated bottled beverages of three distinct types have been made in the laboratory from flavoring sirups containing cassina extract. Formulas have been prepared for the manufacture of cassina-flavored bottled sodas.

### LEATHER INVESTIGATIONS.

The shoe-wearing experiments, conducted jointly with the War Department, which necessitated the complete analysis of 225 samples of leathers and a great amount of work in calculating, tabulating, and correlating analytical and wear data, have been completed and a report made.

Civilian wearing tests were continued during the past year and many additional data have been thus collected on the wearing qualities of the experimental leathers used in the cooperative service tests.

As a result of trials made with machines designed in the bureau to test the relative wearing quality of sole leathers, necessary modifications and improvements have been suggested and are being made.

A report has been prepared in which the following general conclusions are given: Under the conditions of these tests, bark-tanned upper leather was not as satisfactory as were the other types of upper leather; fiber soles, while showing a very high resistance to wear, were not suitable, mainly because of the development of physical failures during service; oak, chestnut, and hemlock sole leather tannages showed practically the same average wear resistance, while belting leather indicated a slightly greater serviceability; chrome sole leathers outwore the vegetable tannages, with unwaxed chrome showing the highest wear resistance. There was practically no difference in the wear of loaded and unloaded leathers; well-rolled leathers showed about 16 per cent more wear than unrolled ones. Soles from the shoulder end of the bend did not show an average wear equal to those from the butt end. Extensive data on the comparative chemical composition of the original leathers and parts of the worn soles are given.

Results showing the effect of relative humidity on the physical properties of leathers, the first extensive ones on this subject, were presented in a paper read at the annual meeting of the American Leather Chemists' Association. The data aroused considerable interest, since they indicated, at least with leathers of a certain type, that humidity has a decided effect which can not be ignored in the accurate physical testing of leather.

Experiments dealing with the relative preservative effects of various oils and greases on leathers were completed and the results presented in a paper before the American Leather Chemists' Association. These results, while interesting and possibly indicative, were not entirely conclusive, and it is planned to carry on more of such work for confirmatory and additional data.

Farmers' Bulletin No. 1183, The Care of Leather, was reissued in revised form. A second revision of Farmers' Bulletin No. 1055, Country Hides and Skins, has also been issued.

The following papers were published during the past year: "The effect of atmospheric humidity on the determination of moisture in leather," "Notes on water extraction of leather," "Rapid washing of chromed hide powder," "The explosiveness of tannery dusts," "The determination of Epsom salts in leather," and "Extraction of oils and greases from leather."

### TANNING ON THE FARM.

In response to the numerous inquiries received daily on methods for home tanning, work on small-scale tanning was conducted to the fullest extent possible under the conditions and means available. Some very satisfactory leather was made in the laboratory, both by the chrome-tanning process and with vegetable tanning extracts, and experiments were also made on tanning fur skins and hides with the hair on. Detailed directions were prepared on making chrome-tanned leather and bark-tanned sole and harness leathers on a small scale, and about 6,000 copies of these directions were sent out in mimeographed form, together with the directions for making alum-tanned leather for belt lacings which were prepared last year. The demand for information on home tanning has continued to increase so that it has been necessary to submit the information so far available for publication as a department circular.

### METHODS FOR MAKING LONGER LASTING LEATHERS.

The limited work under way in this bureau on leather should be expanded into a broad project on tanning materials, tanning, and leather. Agriculture produces the raw materials and uses more of the finished products than does any other industry. Work of great economic and practical importance needs to be done. The total number of hides and skins used in making leather in this country in 1914 was more than 140,000,000, costing the tanners, it is estimated, $240,000,000 plus $45,000,000 worth of tanning, currying, and finishing materials. The factory value of leather goods made from these materials is estimated at more than $650,000,000 for which the ultimate user probably paid at least $1,000,000,000. It is well known that there are large preventable losses in the handling and use of hides and tanning and finishing materials, and that the quality and kind of finished leather and leather products and the processes involved can be much improved.

There is need for better and more durable leathers and for knowledge of how to make, test, and recognize them. Better methods of tanning should materially reduce the cost of shoes and harness to the farmer. Country butchers and farmers now supply about 30 per cent of the hides and skins used in this country. Carelessness, lack of knowledge of taking off, curing and selling these hides and skins cause the loss of about one-third of the value to the farmer. These losses are at least $15,000,000 annually. The proper handling of country domestic hides and skins would materially decrease the quantity imported. The long-used vegetable tanning materials, which are direct products of the forest and the farm, are totally inadequate under present conditions to supply the country's needs. Others should be sought and developed. Through better processes and more intelligent care many millions of dollars can be conserved annually in leather goods. As important as these materials now are to agriculture, they will be much more important as population increases and the domestic supplies are actually and proportionately less.

### RECOVERY AND UTILIZATION OF WOOL-SCOURING WASTES.

Work on the utilization of wool-scouring wastes was continued during the year. The routine analytical work on representative wool samples which was necessary to supplement the fragmentary information available as to the nonfibrous constituents of raw wools from various sources was finished early in the year, completing the data on more than 300 samples of all grades and varieties.

Work was continued on the economical recovery and utilization of potash from wool wash waters and an experimental wool-washing machine has been built to try out a process for removing the potash from wool prior to the regular scouring operation for removal of grease, whereby the potash is obtained in a solution of such concentration that it can be used in preparing mixed fertilizers with little or no further concentration. In collaboration with manufacturers, mixed fertilizers have been prepared on an experimental commercial scale from concentrated wool wash water, acid phosphate, and leather scrap which were found by laboratory examination and analysis to be of good grade and which, in pot tests made by the Bureau of Plant Industry, proved to be satisfactory for promoting the growth of wheat. Samples of both domestic and foreign wool-scouring wastes have been analyzed for comparison of their content of potash and other fertilizer materials. Work on the recovery of potash from the water effluent discharged from the centrifuges of a commercial wool plant indicated that, while the remaining grease and most of the organic matter could be removed by treating the warm liquor with sulphuric acid, ferric sulphate, or preferably calcium chloride and filtering, it was not practicable to recover potash from the treated effluent because of the high cost of concentration.

In cooperation with manufacturers using the solvent scouring process for removing the grease from wool, considerable work has been done on improving the quality of grease obtained from the extracts. It was found that the quality of grease that can be made depends upon the grade of wool that has been extracted. With the improved treatment developed in the laboratory it was possible to obtain an excellent grade of neutral, ashless grease, which was really a good grade of anhydrous lanolin, from solvents used in extracting wools of certain grades.

Work has also been done on the purification of commercially produced wool greases, and in this connection numerous centrifugal and acid-cracked greases have been examined according to the methods devised in the laboratory. The results obtained indicate that while centrifuged greases may be purified and converted into anhydrous lanolin at a reasonable cost, it is impracticable to attempt any further purification of acid-cracked greases.

In cooperation with commercial wool-scouring mills, work has been done on samples of by-products, including scouring liquors from first and second bowls, sediment from scouring bowls, sludge removed from acid-cracking tanks, and filter press cake. A series of experiments has been started to determine the difference between raw wool and scoured wool as regards moisture content under various conditions of temperature and humidity. A paper on "Wool-scouring wastes for fertilizer purposes" was published during the year. Both the direct and indirect results of work of this character are to increase the value of a raw agricultural product after it has been produced, increasing the profit to the producer and lowering the cost to the consumer.

### NAVAL STORES INVESTIGATIONS.

Turpentine and rosin are among the world's important farm and forest crops, and of the total this country produces approximately 70 per cent. Several millions of dollars can be saved annually to the producer through research and demonstration work. The crop is peculiar in that it is grown and gathered in the eight southernmost States, but practically all of it is used north of the Ohio and east of the Mississippi rivers or is exported. The producers have not the facilities or the means of solving the many problems that arise.

As a result of an investigation during the year on methods for producing rosin esters for varnish manufacture, discovery was made of the fact that when zinc or a zinc compound is used as catalyst, rosin and glycerin can be made to combine more easily and more rapidly than was heretofore possible, yielding a product of low acid number and light color. A public-service patent covering this process was obtained. Several varnish manufacturers have cooperated by preparing batches of varnish from samples of rosin ester made in this laboratory and subjecting these varnishes to wear and weathering tests, which are still in progress. Small quantities of complex compounds made from turpentine and sulphur and from turpentine and oxalic acid were prepared to determine whether they could be used in connection with the work on waterproofing of fabrics.

Investigations on the chemical properties of turpentine and rosin have been continued. To determine whether any differences other than color exist between the various grades and varieties of rosin, analyses were made of authentic samples originating at various points in the producing sections. It was found that there is a difference, although not a very marked one, between the chemical properties or constants of light-colored rosins and those of dark-colored rosins.

Incidental to this investigation it was found that the constants of rosin change appreciably and rapidly on standing after being powdered. A sample of rosin produced about 50 years ago was found to have an abnormal tendency to crystallize, crystalline rosin acids being readily obtained from solutions in alcohol. A number of authentic samples of wood rosin examined differed from gum rosin, not only in having a lower melting point but also in having lower saponification, acid, and iodine numbers, and containing more unsaponifiable matter. Several samples of foreign rosins were also examined. Examination of old turpentine samples disclosed the fact that they had developed marked acidity and had a decided solvent effect on iron, zinc, and copper. Several samples of so-called "recovered turpentine" were found to contain oxidized and chlorinated bodies, in addition to the usual turpentine constituents, and were identified as a by-product from the manufacture of synthetic camphor.

In the investigation of analytical methods applicable to turpentine and rosin, a method for detecting and approximately estimating the quantity of coal-tar adulterants in turpentine was devised and published. A study was made of the effects of various solvents upon the results obtained in determining acid and saponification numbers of rosin esters and similar bodies containing metallic resinates. An electrically heated instrument was devised for use in shaping and resurfacing the faces of rosin samples so as to facilitate more accurate grading.

Examinations of 55 samples of turpentine from small paint and general merchandise stores throughout the East showed that the practice of selling adulterated turpentine or mineral oil substitute for pure turpentine is still quite prevalent. In most cases from 10 to 20 per cent of the samples from any locality were found to be adulterated. Regrading in the laboratory of about 1,200 sample cubes of rosin, representing shipments totaling about 10,000 barrels, showed that most of the various lots represented contained considerable misgraded rosin, in some cases as high as 70 per cent. Many instances of misgrading by two grades or more were found.

Samples of gum collected by representatives of the Forest Service from different species of pine in the Florida National Forest were distilled to ascertain the yield of turpentine and rosin, and tests were made to determine the quality of these products.

Two statistical reports were published during the year, including a preliminary report on production and stocks in the hands of principal consumers for the first half of the 1921 naval stores season, and a report showing stocks of turpentine and rosin held by factors, dealers, and exporters at the ports and principal distributing points of the country on March 31, 1922, the end of the 1921 naval stores year. In order to avoid duplication and because the work could be done more economically and efficiently by technologists working on naval stores problems, this bureau entered into an agreement with the Bureau of the Census regarding the collection and compilation of statistics on production of turpentine and rosin and stocks held at the points of manufacture. Statistical data were collected on the distribution of the world's production, trade, and consumption of turpentine and rosin. Additional data have since been compiled and a paper on the subject has been prepared for publication.

Department Bulletin No. 898, Turpentine, Its Sources, Properties, Uses, Transportation, and Marketing, the original edition of which became exhausted soon after publication, was revised and reprinted in September. Department Bulletin No. 1003, The Distillation of Stumpwood and Logging Waste of Western Yellow Pine, was published in December. This completes a project which was conducted in cooperation with the University of Idaho for the purpose of determining the value of different species of wood for distillation purposes and the most profitable utilization of stumps and other wood waste.

Tentative standard types for the four commercial grades of turpentine were prepared. Several sets of these standards, set up for convenient use, have been distributed to State inspectors of naval stores, the chairman of the naval stores committee of the National Paint, Oil, and Varnish Association, and the secretary of the Turpentine and Rosin Producers' Association for use in determining their practicability and permanence. Up to the present time reports have been favorable.

All sets of the standard glass types for rosin were recalled, cleaned, checked against the master set held in the laboratory, and returned to their several depositories for the use of the trade. The use of these standards is becoming more general and is serving a most useful purpose.

### WATERPROOFING AND FIREPROOFING FABRICS.

The weathering experiments started in 1921, which were designed to show the effects on the strength and water resistance of cotton duck exposed to weather when various pigments with formulas previously devised in the laboratory are incorporated, were completed, and a paper giving the results has been prepared for publication. In general, it has been found that the addition of pigments to waterproofing preparations is beneficial since they reduce the injurious effects of solar light and heat without reducing the water resistance.

A paper on "The water resistance of treated canvas during continuous exposure to weather," which embodies a thorough study of the water resistance of 18 waterproofing treatments developed in the laboratory, was published, and one on "The effects of waterproofing materials upon the tensile strength of cotton yarn" was presented at the September meeting of the American Chemical Society.

In response to a number of inquiries concerning treatments which might be suitable for making "glass cloth" from cotton sheeting for covering hotbeds and cold frames, experiments have been conducted and four treatments are now being subjected to a service test. Work has also been done with the object of simplifying the preparation and application of cuprammonium solution to fabrics to such an extent that this might be done on the farm, since the cuprammonium treatment gives greater mildew resistance than any other treatment known at the present time. Tests have been made on the waterproofing qualities of various materials, including complex compounds made from turpentine. Investigations are in progress for the purpose of increasing the life of tobacco shade cloth, which it is estimated costs the tobacco growers $3,000,000 annually. It is hoped to double the life of the cloth.

### MANUFACTURE OF INSECTICIDES.

Work is in progress to determine cheap and effective methods of preparing insecticides and fungicides on a commercial scale, in addition to the chemical investigations on insecticides elsewhere reported. New, efficient, and cheaper insecticides must be found if agricultural workers are to combat successfully or finally exterminate some of the pests most destructive to farm crops. This work includes studies of the properties of commercial insecticides, and during the year progress was made in determining the rate of deterioration in certain materials.

The investigation to determine the rate of deterioration of bleaching powder shows that the rate of deterioration depends mainly upon the temperature at which the material is stored and the type of container. Before publishing any of the results it is intended to repeat the work on samples packed under Government supervision.

Work on the rate of deterioration of nicotine solutions and nicotine dusts of various strengths, packed and stored under different conditions, shows that nicotine solutions and certain types of nicotine dusts deteriorate very slowly when packed in tight containers. Nicotine dusts containing calcium hydrate or carbonate lose strength more rapidly than dusts made up with clay, Kieselguhr, and sulphur.

An investigation has recently been begun to develop an insecticide for use in the control of insects infesting grains in storage and in transit, to take the place of carbon disulphide, the use of which has been prohibited by the railroads. This work is being carried on in cooperation with the Bureau of Entomology. The investigation has not progressed far enough to reach definite conclusions, but some very promising results are being obtained.

The investigation begun two years ago to determine what chemical changes calcium arsenate undergoes during storage has been completed and the results are in process of publication as a department bulletin under the title "Chemical changes in calcium arsenate during storage." This work was taken up as a result of the belief by certain manufacturers and users of this product that it deteriorated rapidly and was unfit for use after standing for a few months. Results of much interest and value have been obtained. They show that carbon dioxide is very slowly absorbed by the calcium arsenate (or by the calcium hydrate which is present in commercial calcium arsenates) when kept in certain types of commercial containers, resulting in a slow gradual increase in water soluble arsenic, which reaches a maximum after about 8 months in the case of the most open containers, such as sugar barrels. Material packed in tight containers, such as metal drums or heavy hardwood barrels, showed practically no change after 20 months' storage. In a few cases where calcium arsenate was stored in veneer drums and sugar barrels, the deterioration at the end of 20 months was such as to render the material of doubtful safety for application on certain plants having tender foliage.

An investigation is being made of the properties of oil emulsions with the object of assisting the manufacturer or grower to make cheaper and more satisfactory emulsions. The value of this work is self-evident when it is considered that large amounts of oil sprays are used each year, particularly on citrus fruits, and that at present these are often unstable and cause damage to the trees.

A paper, "Errors caused by nitrates and nitrites in the determination of arsenic by the distillation method and a means for their prevention," was also published.

### PREVENTION OF PLANT DUST EXPLOSIONS AND COTTON GIN FIRES.

Investigations by the Bureau of Chemistry have shown that the dust that is produced in the handling and milling of grain of all kinds, when mixed with air in proper proportions, is highly explosive. It forms a mixture similar to the explosive mixtures of gas and gasoline. A large number of disastrous explosions have occurred in the thrashing and milling of grain, resulting in extensive losses to life and property. In 13 recent dust explosions in the United States and Canada, 154 lives have been lost, over 200 people have been injured, and grain and property, valued at more than $16,250,000, have been destroyed. These explosions have occurred in practically every type of plant or manufacturing establishment where explosive dust is created during operating processes. In addition to the explosions in industrial plants, extensive losses have been experienced in grain-thrashing machines and from fires in cotton gins and cotton-oil mills.

The expansion to a larger operating scale, the capacity for increased production, and the development of industry, combined with the introduction of new methods and types of mechanical equipment for grain handling, have resulted in additional dust-explosion hazard.

It is necessary to determine fully the nature and behavior of these dust explosions, the sources of ignition, and circumstances under which they occur, together with methods of prevention, before effective control can be brought about. The bureau has been called upon to assist in determining the causes of a large number of explosions that have occurred in various types of industries, in addition to those occurring in grain-handling plants, and has definitely established the fact that all industries in which these dusts are produced during operating processes are subject to this hazard. The largest losses at the present time are occurring in the grain elevators in the terminal markets in connection with the handling, elevating, and storing of grain. The lack of knowledge on the subject and the absence of definite control methods have resulted in extensive losses to life, grain, and property.

The investigations of the Bureau of Chemistry relating to plant dust explosions and fires have been very definitely conducted along three distinct lines: (1) Dust explosions that occur during the handling and milling of grain in elevators and industrial plants; (2) fires and explosions in grain thrashing machines; and (3) fires in cotton gins and cotton-oil mills. Very definite results have been obtained in the investigations of explosions and fires in grain-thrashing machines and effective control methods have been developed by the bureau. In the Pacific Northwest, including the agricultural sections of eastern Washington, northern Idaho, and northeastern Oregon, these explosions have been controlled by (1) the installation of specially designed dust-collecting fans for the removal of the explosive smut dust and (2) the application of grounding systems for the purpose of conducting static electricity away from the machine. One of the principal causes of these thrasher explosions appears to be the ignition of the dust and air mixture by static electric sparks produced during thrashing operations. The bureau has cooperated with the State fire commissioner of Washington and other State officials in special investigations to determine the efficiency of these preventive methods, and the results obtained have been sufficiently encouraging to terminate the investigational work on this phase of the subject. This part of the bureau's work has been a definite contribution to the prevention of these explosions in thrashing machines, and arrangements have been made with the extension forces of the department for the application of these preventive measures. The fans that have been designed have not only proved effective in explosion control but have also indicated their value in cleaning the grain and preventing the wind dissemination of smut spores.

In the studies of explosions in grain-handling plants, the bureau has been able to determine a number of the causes and develop effective control methods. Special experimental work has shown that the breaking of electric lamp bulbs in dust clouds has been responsible for a number of explosions, and, in cooperation with the manufacturing companies, special equipment consisting of a vapor-proof bulb, properly guarded, has been developed and recommended. These recommendations are covered in Department Circular No. 171. It has also been found that explosions can be controlled by the use of inert gases for the prevention of flame propagation. The bureau has shown that by reduction of the oxygen content and the introduction of carbon dioxide the explosion can be confined locally and the extent minimized.

Attention has been given to the design and development of a rotor separator which can be attached to suction fans to prevent the passing on to the dust collector of any grain drawn in with the dust-laden air. A patent has been granted on the attachment and preliminary tests with a small model justify further tests under actual operating conditions.

The explosive limits indicating the amount of dust and air necessary to form an explosive mixture have been determined for a number of dusts. It appears that the various kinds of dusts have various ranges of explosibility similar to various gases. It has been determined that as small an amount as 0.02 ounce per cubic foot will form an explosive mixture of grain dust and air.

As a result of the bureau's work on the subject, the industrial commissions, safety associations, and insurance organizations of the United States and Canada have made applications of the preventive methods already developed, with the result that the importance of the problem is being well recognized and the bureau is being constantly called upon to test various kinds of dust to determine their explosibility and to suggest control methods. Recent explosions of new kinds of dust have been occurring, and the bureau has been called upon to study a series of explosions of lime-sulphur and insecticide dust being manufactured in powdered form. Special assistance has been given to the industrial commission of Wisconsin in a study of dust-control methods in grain elevators in line with efforts being made by the Canadian Government and safety organizations in the United States.

A large number of bulletins, circulars, pamphlets, leaflets, and cards have been issued by the bureau dealing with the causes of these explosions as they have been established by investigation and with control methods that have been determined by experimental work. There has been an active demand by the agricultural interests and the industries of the country for these publications, and they have been the basis of State and municipal control and supervision.

### UTILIZATION OF FRUITS AND VEGETABLES.

Work on the factory production of sweet-potato sirup at Fitzgerald, Ga., was completed during the year and a report prepared for publication. This report gives all of the data developed in the laboratory experiments and in the factory work that will be of value to anyone undertaking the production of sweet-potato sirup. In general, the results of the factory work substantiated those previously obtained in the laboratory. It was practicable to produce a clear sweet-potato sirup of excellent flavor on a small factory scale. It is believed that the process developed will provide an outlet for many of the cull and surplus sweet potatoes.

Work in the laboratory was done on the changes which occur in the sweet potato on heating, and these results were submitted for publication. Before this work was done it was well known that the sweet potato contains large quantities of an active diastase. The laboratory results show that the diastase is so well distributed throughout the sweet potato and is so closely associated with sweet-potato starch that more or less complete hydrolysis of starch results whenever sweet potatoes are cooked. The action is very rapid, and, indeed, it was found difficult to heat sweet potatoes in any way without causing some digestion of the starch through the action of the diastase. The principal carbohydrate formed was found to be maltose.

This study is believed to have value in guiding future efforts which may be made in converting surplus and cull sweet potatoes into economic products. For example, if it should be desired to convert potatoes into the dehydrated form, for use in alcohol or vinegar production, the recognition of the presence of the diastase and its action in digesting the starch upon cooking would be of great assistance in the determination of the process to be used.

Investigations to improve further methods for the utilization of cull and surplus oranges and lemons were continued at Los Angeles, Calif. The development of commercial industries utilizing much of the cull and surplus citrus fruit of California has been reported previously. Several concerns are now profitably manufacturing valuable commodities from fruit by methods resulting from these investigations. Growers of fruit can now dispose of culls at a greatly increased price. A paper on the work on orange vinegar was published during the year. Work on the crystallization of citric acid without previous precipitation as calcium citrate was completed. An investigation was made of the use of dialysis in the preparation of commercial pectin from the waste products of both oranges and lemons. The laboratory work has reached a stage where manufacture on a semicommercial scale will soon be started.

Progress was made in the investigations aimed to improve processes for the dehydration of fruits and vegetables. Dehydrated fruits and vegetables greatly superior in appearance and flavor to the old-fashioned dried products have been put on the market. It is expected that still further improvements will result from this work. The dehydration work was transferred on July 1, 1922, from Washington to Los Angeles, Calif., and combined with the laboratory which has done such excellent work on the utilization of oranges and lemons. This change enables the bureau to effect certain economies and to increase the efficiency of the work.

Work similar to that in utilizing by-products from oranges and lemons, however, should be extended to include other fruits and vegetables. Every year there are a great many cull fruits and vegetables which are not suitable for sale as food. It is believed that great quantities of these by-products of the farm could be turned into profitable products if adequate study from a chemical technological viewpoint were made of the possibilities. There is a great field for further development in the matter of fruit juices. The bureau has already done enough work along this line to indicate that a great deal of the fruit which now goes to waste or is used with small profit to the farmer can possibly be used in the manufacture of fruit beverages, thus increasing the profits to the producer.

## WORK FOR OTHER DEPARTMENTS.

The Bureau of Chemistry does a large volume of chemical and technological work for the other departments of the Government, in addition to the extensive work done for other bureaus of the Department of Agriculture. The specialists in the bureau act as consulting chemists to other departments, aiding in the solution of problems based on chemical methods. This service not only saves the Government the expense of maintaining a number of small laboratories in various departments, which in the aggregate would cost a large sum to maintain, but makes available for this work a larger staff of specialists than is elsewhere assembled. The work can be done by men who specialize much more economically and efficiently than by men who work on a great variety of products as chemists in a small laboratory are usually required to do.

The volume of work done for other departments has become so large, however, that it can now be done only at the expense of the work with which the Bureau of Chemistry is primarily concerned and for which its appropriations are made, that is, agricultural chemical investigations, the enforcement of the Federal food and drugs act, and the tea inspection act. A small appropriation is made annually to defray the cost of such work, but this sum is inadequate to meet the requests for assistance from other departments.

One of the most important lines of work is that for the Post Office Department in the application of the law relating to the fraudulent use of the mails to so-called remedies and mail-order treatments for a great variety of diseases and disorders, ranging from obesity cures to sure cures for tuberculosis or cancer. In order to apply the law to fraudulent preparations of this nature it is necessary that a chemical analysis be made of the materials and that expert testimony be furnished as to the ineffectiveness of the ingredients to alleviate or cure the diseases for which the preparations are fraudulently sold through the mails. Dealers in fraudulent cures can frequently be reached more effectively through the application of the mail-order law than the food and drugs act; in fact, effective control in this manner can be inaugurated in certain instances where the food and drugs act lacks jurisdiction. During the year the major portion of the time of the staff of the drug division of the bureau was devoted to the analysis of samples of these products and to furnishing assistance to the officials of the Post Office Department in conducting hearings and preparing and prosecuting court cases.

A large number of samples of foods and drugs were analyzed for the War and Navy Departments to see that they complied with the standards under which they were purchased. This work is carried on not only in the various laboratories in Washington but also in the laboratories of the branch stations located in the leading trade centers throughout the country. Other work included examination of a great variety of samples for the different Government departments and independent establishments.

Assistance has been given to the congressional Joint Committee on Printing in the preparation of paper specifications, and to the Public Printer in establishing a testing section at the Government Printing Office for testing paper and other supplies. About 50 samples of bookbinding leathers were examined for the Government Printing Office to assist in checking deliveries against standard samples, drawing specifications, and making awards. Information was supplied to the Navy Department on proposed specifications for pneumatic and hydraulic leathers of high heat resistance. A statement on the composition and adulteration of leather was prepared for the Federal Trade Commission.

## COLOR INVESTIGATIONS.

Investigations to aid in the development of a dye industry in the United States were continued. The practical results obtained in the discovery of processes for the manufacture of certain dye intermediates, which enable American manufacturers to make these intermediates in competition with German manufacturers who at one time monopolized their manufacture, were previously reported.

*Indigo.*—Indigo is one of the most important dyes manufactured in the United States. The process at present in use in this country has been not altogether satisfactory, and an investigation was undertaken with a view of substituting an alternative method for the preparation of this dye. A survey was made of the entire process and the results obtained indicate that indigo of good quality can be obtained at a somewhat lower price than is possible by the method now in vogue. Two papers on this work were published.

*Indigo derivative from cymene.*—A new dye similar in dyeing properties to indigo has been made from cymene—a waste product obtained in the preparation of paper pulp from certain resinous wood. A paper giving a detailed description for making this dye was published.

*Anthraquinone from anthracene.*—Anthraquinone is an intermediate used in the preparation of the valuable dye "alizarin." A relatively simple method was worked out for the making of anthraquinone from anthracene, one of the "crudes" obtained from coal tar, using the oxygen of the air instead of the rather expensive chemicals heretofore used. A public-service patent was granted on this process.

*Vital red.*—Although this dye is used in only small amounts, it is nevertheless of tremendous importance both in time of peace and in war. It is used by physicians in testing blood volume. The medical men have been unable to secure the dye in this country in satisfactory quality and accordingly a complete study of the method of preparation was undertaken. Several batches have already been prepared and submitted to expert medical investigators for examination. Work on this dye is being continued.

*Photosensitizing dyes.*—These dyes are used in photographic work, especially in aerial and astronomical photography. Improvements have been made in the preparation of a number of these dyes. A new method for making the dye known as "dicyanine" was discovered and a public-service patent applied for.

*New analytical method.*—The greatest need of the dye industry at the present time is for better methods of analyzing dyes and intermediates used in preparing them in order to produce dyes that will give uniform results. Work along this line was undertaken and a new method devised for the detection of "H" acid, a substance used very extensively in the dye industry. A full description of the method was published in one of the technical journals.

*Physical chemical measurements.*—Inasmuch as no reliable data were available on certain physical constants of the more important intermediates, work was undertaken for their determination. Vapor pressure measurements were made on naphthalene, anthracene, phenanthrene, and anthraquinone. The solubility of certain naphthalene sulphonic acids which are used in the dye industry was determined.

*Standardization of biological stains.*—A chemical study of the pre-war German biological stains and of the American product which is being manufactured to take their place, with rather unsatisfactory results in some instances, was undertaken. Inasmuch as these stains are used by bacteriologists, pathologists, physicians, and veterinarians in the study and identification of disease-producing organisms, it is of the greatest importance that only stains of uniform and constant composition be used for such work. This problem is of importance to the country, inasmuch as the health of the citizens and also the health of the live stock and plant crops of the country are vitally concerned. In view of the rather extensive nature of the problem, only the most important of the biological stains were investigated during the year. It was found that certain American stains were equal to the pre-war German stains, whereas others were unsatisfactory. The methods for preparing these stains are being thoroughly investigated and an effort made to standardize the methods of preparation so as to obtain a uniform product. This work is being pushed rapidly and the possibility of devising quick and accurate analytical control methods is being investigated.

*Production of thymol from cymene.*—Thymol is a drug that is used extensively as an antiseptic, but more especially as a specific against the hookworm disease. It is now imported from India, where it is found in the seed of one of the plants indigenous to that country. It was discovered, however, that synthetic thymol identical with the natural product can be obtained from cymene, a waste product in the paper industry. It is estimated that 2,000,000 gallons of cymene are wasted annually in this country and Canada. Thymol is now sold for $4.50 per pound, whereas it is estimated that the synthetic product can be made for about $2.50 per pound. A public-service patent on the process has been applied for. Several chemical manufacturers have already become interested in it, and it is quite likely that this country will soon be able to produce all the thymol consumed here.

*Certification of dyes.*—The work on the certification of dyes is done in the analytical section of the laboratory. This is part of the food and drug enforcement work. A certain limited number of dyes are permitted to be used for coloring food products. The dyes are tested for arsenic and other injurious and poisonous substances that may be there, and if found present the dye is rejected. Determinations on the strength of the dye are also made. If the sample submitted comes up to standard a certificate for the particular batch of dye from which the sample was taken is issued. From 8,000 to 9,000 pounds of dyes are thus certified every month.

## ENFORCEMENT OF REGULATORY STATUTES.

### THE FOOD AND DRUGS ACT.

The magnitude of the food industry is indicated by the latest statistics of the Bureau of the Census of certain manufacturing industries which show that in 1919, 67,453 establishments were engaged in the manufacture of food products. The annual value of the products of these establishments was $13,391,914,000. These figures cover only manufactured foods and do not take into account the great volume of commerce in nonmanufactured foods, such as milk, fresh fish, raw oysters, wheat, corn, oats, all fresh fruits and vegetables, and the like, to which the food and drugs act also applies when they are shipped within the jurisdiction of this act. Imported food products, which also come under the provision of this act, were valued during the calendar year 1921 at $672,975,456. The annual cost of enforcing the Federal food and drugs act is less than one hundredth of 1 per cent of the value of the foreign and domestic products coming within its jurisdiction.

#### Project System.

The food and drugs act is corrective rather than punitive. Its effective enforcement is of advantage primarily to consumers but also to the great majority of those engaged in the food industry who do an honest business since it eliminates competition with adulterated, debased products and promotes fair trading.

Owing to the magnitude of the food and drug industries, the extensive territory to be covered, and the great variety of products to which the food and drugs act applies, it is possible to maintain an effective supervision of interstate and foreign commerce in these products with a small organization only by having every unit of the organization working in unison towards a common end and in accordance with a definitely planned schedule. This is accomplished by preparing before the beginning of each fiscal year a schedule of projects which includes all the important lines of work to receive attention during the year, and a definite plan of attack for each line, showing the time the work is to be done and the part to be done by each unit of the organization.

Before laying out a campaign to correct any particular trade abuse that violates the provisions of the food and drugs act, a careful survey of the industry involved, to determine the extent of the violation and its effect on consumers and the trade, is made by the units of the field force that are in the best position to do it effectively, and a preliminary plan of action is prepared. This plan of action is considered by the administrative officers of the bureau and by the staff specialists in the light of the knowledge developed by the survey and investigations in the staff laboratories. The value of the work to be done and of the evidence to be obtained is determined and a definite plan of action approved. It then becomes a part of the schedule of work for the year and the districts proceed to carry it into effect.

The success of this plan of control involves a proper understanding between the administrative officers in the field and those in Washington. This is brought about chiefly by the special or staff laboratories and offices of the bureau whose services are of a liaison character. The plan is thoroughly cooperative and contemplates a proper articulation of every agency whose work has any bearing on any one of the schedules.

## Cooperation with State and City Governments.

The work of the Federal Government in regulating interstate and foreign commerce in foods and drugs supplements but does not displace the work of State and city governments in regulating the manufacture and sale of these products within their respective jurisdictions. A State officer in Ohio can not reach a manufacturer in New York who ships adulterated food into that State, but such a manufacturer may be reached through the operation of the Federal food and drugs act. While the fields of operation of the Federal, State, and city food and drug control officials are separate and distinct, they are working for the same general objects and upon the same kinds of products, so they have many problems in common. The efficiency of the work can be promoted and its cost kept at the minimum through close cooperation among all food and drug officials. There is maintained in the Bureau of Chemistry an office of cooperation, the main function of which is to promote effective teamwork in the enforcement of food and drug laws, especially through the exchange of information regarding methods of analysis and inspection, commercial practices, standards, violations of law, and the like.

Gratifying results have been obtained in the increased correspondence and requests for information, as well as by the receipt of information from those officials in various ways. Very satisfactory reports have been received from the field forces as to the cooperation being received from the various State and city departments, and especially from several States and cities where heretofore the cooperation had been relatively undeveloped. In addition to the maintenance of cooperation already developed among State officials, an attempt has been made to secure more active cooperation on the part of municipal officials engaged in food and drug law enforcement. Results so far have been very encouraging, and it is the plan to prosecute work along these lines during the present fiscal year.

## Work of the Staff Laboratories.

The work of the staff laboratories during the year has been directed in accordance with the project scheme of handling regulatory problems. These laboratories manned with specialists study the many problems involved in applying the food and drugs act to specific products. They work out methods for detecting adulteration, collect data regarding processes of manufacture, study the composition of foods and of materials that enter into the manufacture of food, review evidence in cases, furnish expert testimony, and in general develop information to aid the administrative offices of the bureau in arriving at decisions and in formulating policies and to aid the field offices in carrying out their regulatory projects.

The following investigations by certain of the staff laboratories indicate some of the more important problems under consideration and illustrate the variety and extent of the work.

### FOOD-CONTROL INVESTIGATIONS.

The food-control laboratory, which, as its name indicates, supervises the chemical work on foods, also conducts investigations necessary for effective food control not provided for in other staff laboratories. The hydrogen-ion concentration of egg whites is being studied with the view of determining its effect on the whipping qualities of the different egg-white preparations. Methods of analysis have been worked out in preparation for a study of the composition of alimentary pastes and the raw materials used in their manufacture. In connection with the investigation of alimentary pastes, samples of whole eggs, egg yolks, and egg albumen in the dried condition were collected and analyzed in order to assist in determining the nature of the egg material used in egg noodles. A method for detecting remade milk has been published. All available data on flour grades and flour standards were assembled and submitted to the joint committee on definitions and standards for consideration in formulating standards. Experimental batches of prepared mustard have been analyzed in a study of mustard products with the view of preparing recommendations for the labeling of mustard products containing hulls and turmeric. Numerous analyses of authentic samples of cocoa nibs were made and the data submitted to the joint committee on definitions and standards for a revision of the cocoa and chocolate standards.

### MICROBIOLOGICAL INVESTIGATIONS.

The microbiological laboratory investigates food problems in which bacteria and other microorganisms are involved. This includes the examination of samples taken under the food and drugs act to detect adulteration, contamination, and pollution. The laboratory controls the microbiological examination of foods and drugs in the three field districts of the bureau. During the year special attention was given to the examination of water for pollution, salmon for spoilage, and canned foods, particularly spinach, for *Bacillus botulinus*.

A boric-acid canning powder was investigated to determine its value and fitness for use in canning. In the practical canning experiments the use of the powder for acid products was shown to be an unnecessary and wasteful practice, since material packed without the powder kept as well as that packed with it. Its use with the more or less neutral vegetables showed that the powder plus the inadequate heating recommended was not sufficient to preserve the materials or to prevent the production of toxin in them by *B. botulinus*. As the result of the investigation a circular has been published on "Some experiments with a boric-acid canning powder."

In the investigation of the control of cream and butter further work was done for the purpose of correlating the microscopic count of oidia and yeasts with the physical condition of the cream used in manufacture. These investigations clearly show that a general correlation can be established between low counts of these organisms in butter and the use of good cream and between comparatively high counts and the use of generally old cream, but the methods used in manufacture destroy the quantitative value of such counts in estimating the relative age or relative deterioration of the different samples. It is therefore perfectly possible by microscopic examination to show that old cream has been used, although it is not possible to determine how bad the sample of old cream was before manufacture.

The results of this investigation were published during the year in papers entitled "Determination of yeasts and oidia in high-grade experimental butter," "The volatile acids and the volatile oxidizable substances of cream and experimental butter," "Creamery inspection data," and "Determination of yeasts and oidia in cream and butter."

The investigation of salmon canning has furnished an adequate experimental basis for correlating the texture and odor of the fish as found in the commercially canned product with the condition of the fish before canning. By this work, in which experimental packs of fish in known condition were prepared, a basis has been furnished for satisfactory testimony in court with reference to this product. No other means would have given the adequate information obtained in this manner. The results have been published in papers entitled "Decomposition of 'feedy' salmon," "A comparative study of spoilage in salmon," and "The sources and characteristics of the bacteria in decomposing salmon."

Work is under way on condensed milk, to develop a method of examination of the finished product which will reveal the condition of the raw milk as received at the condensery. The application of such a method will make it possible to regulate traffic in condensed milk made from raw milk of insanitary quality.

In connection with the study of molds, their activity as fermenting agents in certain food products has been a subject of investigation over a period of years. One of the products studied has been soy sauce, which is produced by the fermentation of soy beans and wheat, using various strains of Aspergillus belonging to the flavus-oryzæ group as the principal agent of fermentation. In this work the bureau had the voluntary assistance for six months of Dr. Kokichi Oshima, a Japanese student from Sapporo, Japan, who submitted at the close of his work two papers. One of them has been published under the title, "Promising development of soya-bean sauce (studies on the protease of the Aspergillus oryzæ-flavus group and its rôle in shoyu brewing)." The other, concerning the diastatic activity of the same group of organisms, is in course of publication.

A study has been made of the bacteriology of dried eggs and the correlation of the bacteriological condition of the dried product with the character of the materials used in manufacture. In general, the physical results of the experimental work show that eggs in perfect condition before drying produce a product entirely free from objectionable odors, that the spray process will remove much of the objectionable odor from eggs which would be rejected if examined in fresh condition, and that the spray process does not remove the objectionable odor from eggs which were completely rotten. The difficulty involved, therefore, covers eggs which have reached the stage of being clearly objectionable without having become positively putrid. Further investigation should give a valuable contribution to the enforcement of the food and drugs act against dried products.

Cultural studies of Penicillium and Aspergillus and species of related genera were continued, and a stock of cultures maintained. This collection is of great value in undertaking the identification of microorganisms occurring in the course of work with food products and in answering inquiries from laboratories throughout the world.

Work on the classification of the bacteria occurring in food products was continued and a study made of the paratyphoid-enteritidis group of bacteria. This group is believed to be responsible for the majority of the outbreaks of food poisoning which are popularly designated "ptomaine poisoning" and are characterized by acute intestinal distress, accompanied by nausea, vomiting, and purging. To obtain information upon this subject, a careful survey of a series of these cultures has been made, followed by a series of experiments with foodstuffs under the conditions ordinarily occurring during the handling of food in the household. These results are embodied in a paper entitled "Development of the paratyphoid-enteritidis group in various foodstuffs," which has been prepared for publication.

A comparative study of the floras of spoiled canned foods was continued. Special attention was given to a study of botulism, since poisoning of this character in this country has been almost entirely due to canned foods. In the course of the year several poisoning cases due to canned spinach have occurred, involving a continuation of the study of this product. Extensive work of a regulatory character was accompanied by a detailed experimental study of the possibilities of poisoning due to spinach.

In general, the work was confirmatory of the work done in the preceding year with this same product, which has recently been published as "Observations on *Bacillus botulinus* infection of canned spinach." The conclusion seems to be legitimate that a scrupulous examination of cans of spinach before opening and at the time of opening would eliminate the danger of botulism in handling this product or so nearly eliminate it as to render the chances of poisoning negligible. Experiments in the laboratory clearly show that if products which even were questionable were simply boiled after opening, there would be no danger whatsoever. The recommendation, therefore, is that a careful examination of the cans at the time of opening be made and that as a supplementary precaution, if the product passes the physical examination, it be also boiled.

Another line of investigation in connection with botulism was the incubation of a series of samples of foodstuffs in conditions simulating those occurring in the household. These investigations clearly show that poisoning of this character might readily occur if left-over foods were kept at room temperature in pantries, storerooms, or other places sufficiently warm to permit the growth of the organism, but that in the temperature of a properly kept ice refrigerator foodstuffs, even though contaminated, would not become dangerous within a period of two or three days. This work is being prepared for publication.

### MICROCHEMICAL INVESTIGATIONS.

The microchemical laboratory makes examinations and studies of food and other products involving the use of the microscope. It investigated during the year methods of grading, sampling, and examining nuts. A large number of import samples of canned and dried mushrooms have been examined for insect infestation. Studies were conducted upon decomposition in fruits with a view to arriving at criteria for judgment of this class of products under the food and drugs act. These studies included blackberries, raspberries, loganberries, peaches, and apple products. As a result of this work the bureau is in a better position to judge such products than ever before.

Studies made upon flour with a view to grading the product by microscopical means have been further extended during the past season and a modified microscopical method for examination has been devised which simplifies considerably the method as originally worked out and published.

Further studies upon methods of estimating the shell content in cocoa and chocolate products have been made and a method tentatively adopted.

Regulatory work in the examination of samples and the review and preparation of evidence in cases was continued during the year and involved principally the following food products: Tomatoes, cocoa and chocolate, egg substitutes, nuts, canned fruits, stock feeds, and jams and jellies.

### CONTROL OF STOCK FEEDS.

The cattle food and grain investigation laboratory performs the services of a staff laboratory in applying the food and drugs act to stock feeds and grains. All cases involving these products are reviewed and recommendations made. Information regarding stock feed and grains is furnished the inspection districts to guide them in applying the law to adulterated and misbranded products. Work was done to determine standards and definitions for various cattle feeds, and to unify the methods of analysis used in the various laboratories of the bureau.

### CONTROL OF BEVERAGES.

The water and beverage laboratory acts as a staff laboratory in the control of water, beverages, flavors, and related products. In cooperation with the stations of the eastern district, a sanitary survey was made of mineral springs located in Virginia, West Virginia, North Carolina, South Carolina, and Georgia. A paper on "Radioactivity of miscellaneous waters examined in the Bureau of Chemistry" is in course of publication. Much attention was given to the labeling of flavoring sirups and beverages, particularly those of the orange type.

A series of articles on "Food flavors, source, composition, and adulteration" is being published in a number of trade journals. A paper on "Relative sweetness of invert sugar" was also published. Papers on "Mineral waters of unusual composition," "Specific gravity of mineral waters by calculation," and "Studies on flavors, beverages, and related products" were presented at the annual meeting of the American Chemical Society. Other papers published during the year included "Purity of bottled spring water" and "Mineral composition of seventy city water supplies."

### PHARMACOGNOSY INVESTIGATIONS.

The pharmacognosy laboratory supervises the work involved in the application of the food and drugs act to crude drugs and spices, both imported and domestic. During the year special attention was given to a campaign to eliminate excessive dirt from domestic crude drugs. An investigation showed that the shipping of dirty domestic crude drugs is a rather widespread practice and is due largely to carelessness in gathering. Excessive dirt constitutes adulteration in crude drugs shipped within the jurisdiction of the act. In some instances crude drugs were found to contain 20 per cent or more of dirt, which obviously lessens the medicinal value of the drug. Preliminary educational work was carried on and plans formulated to take such regulatory action as may be necessary to correct this abuse.

Examination was made of the usual number of imported drug plants. Several shipments were found to be incorrectly labeled as to the plant from which obtained. Special attention was given to marjoram, since new adulterants were found, especially cistus leaves, which were sometimes present up to 25 per cent or more.

The results of the researches of the pharmacognosy laboratory were published in scientific and trade journals under the following titles: "Fake saffron"; "Domestic and imported veratrum (hellebore), Veratrum viride, etc."; "Alkaloids in rhizomes and roots of ipecac"; "A report on the zamia starch situation"; "The substitution of convallaria flowers for chamomile"; "Interesting substitutes for food and drug products"; "Edible and poisonous beans of the lima type"; "Robusta coffee"; "A saponin from Agave lechuguilla Torrey"; "Volume weight determinations of crude drugs and spices"; "Microsublimation of plant products"; "Identification of crude drug substitutes"; and "A new source of santonin."

### PHARMACOLOGICAL INVESTIGATIONS.

The pharmacological laboratory studies the physiological effects of certain heavy metals, toxic substances, dyes, and other materials that are sometimes found in minute quantities in foods, to develop information on which to base decisions controlling their use under the food and drugs act. A paper was prepared on habituation to and the toxicity of arsenic trioxide. Experiments were conducted to ascertain whether animals become immune to arsenic. Chronic intoxication has also been studied. Several toxic preparations of arsenious oxide were prepared for the Biological Survey to be used in poisoning tests for the control of predatory animals. A public-service patent covering the preparations and their manufacture has been applied for. Department Bulletin No. 1023 on the action of strychnine as a rat poison has been published. Two papers have also been published dealing with the action of strychnine. A report was made covering the toxicity of a series of dyes. Studies were continued on the toxicity of fat soluble dyes.

### CONTROL OF MEDICINAL PREPARATIONS.

The office of drug administration is the staff advisor in the application of the food and drugs act to pharmaceuticals and to proprietary and other preparations which are sold as remedies for disease. The director of this office is a surgeon of the United States Public Health Service detailed to this bureau for the purpose. All matters involving the adulteration or misbranding of drug products are reviewed in this office, and evidence prepared to support the Government charges in court action. Plans for the correction of such adulteration and misbranding are formulated, and a general supervision maintained of all the work relating to the control of labeling medicines under the food and drugs act.

## WORK OF THE FOOD AND DRUG INSPECTION DISTRICTS.

The field force of the bureau makes factory inspections, collects and analyzes samples, holds hearings under the law, studies trade practices and in general formulates plans of atttack, and carries out the policies of the department and the orders of the courts. For the purpose of maintaining a closer supervision under the food and drugs act over interstate and foreign commerce in foods and drugs it is divided into eastern, central, and western food and drug inspection districts, with headquarters, respectively, in New York, Chicago, and San Francisco. The work of each of these districts is carried on under the direction of a district chief, through stations strategically located in the leading trade centers. The stations of the eastern district are in New York, Philadelphia, Boston, Buffalo, Baltimore, Savannah, and Porto Rico; those of the central district in Chicago, St. Louis, Kansas City, Cincinnati, Minneapolis, and New Orleans; and those in the western district in San Francisco, Seattle, Los Angeles, and Denver.

### SPECIAL FEATURES OF YEAR'S WORK.

The work under the food and drugs act during the year covered as usual a great variety of foods and drugs. Much work was done on a number of projects which seemed to require special attention because of conditions found to exist during the year.

*Vinegar.*—Attention was given to the practice of some firms of selling as cider vinegar or as apple vinegar a vinegar made from dried-apple products. The department had previously announced in food-inspection decision No. 140 that vinegar made from dried-apple products should be plainly marked to show the material from which produced. Certain manufacturers appealed to the department to change this ruling. A public hearing was given in August, 1921, to those interested in the question. A case came up for judicial determination in the Federal court in Milwaukee, Wis., in December, 1921, with the result that the court sustained the position taken by the department. However, certain concerns continued to ship into interstate commerce vinegar misbranded in this respect, and it became necessary for the department to seize a large number of shipments in order to check the practice. Certain of these cases are still pending before the courts.

*Flour.*—In examining shipments of flour to see that bleached flour coming within the jurisdiction of the food and drugs act was labeled as bleached, it was found that many of the shipments to the Pacific coast contained excessive moisture and were short of the weight declared upon the labels. Seizure of numerous shipments was effected and a number of shippers were cited to hearings.

*Canned spinach.*—A few cases of botulism having been traced to canned spinach, special attention was given to this product during the year. The California board of health issued regulations prescribing the time and temperature at which canned spinach put up in that State should be processed. The San Francisco and Los Angeles stations made complete and systematic inspections of canneries putting up spinach, giving particular attention to the condition of raw material entering the packs, length of time held before canning, temperatures and time of processing, cut-out weights, and the like.

*Tomato products.*—Canned tomatoes and tomato products, such as catsup, pulp, and purée, have received the attention of all three food and drug inspection districts for several years. Where careful sorting is not employed it is possible to incorporate considerable portions of moldy or rotten tomatoes, especially in such products as pulp and purée, without detection of their presence by consumers. Reports of the work during the last fiscal year indicate, however, that a great improvement has been made in these products, and that the extensive educational and regulatory work carried on during previous years has been quite effective.

In the course of the bureau's regulatory work on canned tomatoes and tomato products it early became evident that the size and distribution of the industry was such that progress in the elimination of unsatisfactory conditions could be made only by operation under an organized plan of action. Accordingly, during the packing season of 1917 the work was first outlined on a project basis, although owing to the limited field force it was impossible to carry it on in an extensive way during that year. During succeeding seasons the inspection districts have been able to give increasingly more attention to the project. The project plan which has been followed with minor modifications consists in (1) listing all plants in each station territory; (2) preseason or early season inspections of all plants not previously inspected, with constructive suggestions as to improvements where necessary; (3) classification of all plants according to their practices, whether good, bad, or questionable; (4) follow-up inspections during the packing season of bad and questionable plants to determine whether unsatisfactory conditions have been corrected or still prevail; (5) collection of authentic samples of unadulterated goods for comparison purposes; (6) reporting interstate shipments from establishments believed to be manufacturing adulterated products and collection and examination of samples, followed by regulatory action.

Factory inspections are made by men especially trained for the purpose, and suggestions are freely offered to packers where it appears that corrections in their practices will improve the character of the output. Complete records of inspections and of all suggestions are made on special factory inspection report forms

*Frozen oranges.*—Owing to a severe freeze in California in January, 1922, about 40 per cent of the orange crop was frozen to a degree that rendered it unfit for food. Frozen oranges may not show evidence of damage immediately after freezing, but they deteriorate gradually for several weeks and ultimately develop a dry and juiceless condition, varying in degree with the extent of frosting. Thus a shipment apparently uninjured when packed may become practically worthless by the time it reaches an eastern market. It is to the interest of the trade as a whole to keep such fruit from the market.

The State of California, in the interest of the orange industry of the State, issued drastic regulations to prevent the shipment of frozen oranges Through the cooperative efforts of Federal and State inspectors a close watch was kept on shipments of oranges, and several shipments of the frozen fruit were seized under the Federal food and drugs act in the various sections of the United States to which they were shipped. This was made possible through the unified action of the various stations of the bureau.

*Stock feed.*—Work on the control of stock feeds is an important project in the three inspection districts, but particularly so in the central district, which is the chief producing section in the country. Most of the States require by law that the labels on packages of stock feeds shall show the percentage of protein, fat, crude fiber, and other substances which indicate the probable feeding value of the product. Incorrect branding in this particular is in violation of the Federal law where the product is shipped interstate. Extensive work on the part of the field force has been necessary to check this form of misbranding. Another form of adulteration to which attention was given was the addition of water and screenings to oats. Other feed products investigated include cotton seed, mixed feeds, alfalfa meal, linseed meal, barley products, and the like. Reports from the inspection districts indicate that there has been less adulteration and misbranding in feeds since the cost of feed ingredients has decreased than was prevalent when prices were high during and immediately following the war.

*Chloroform.*—A campaign was carried on during the year by Federal, State, and city officials to eliminate from the market decomposed chloroform put up in tins and found to be unfit for anesthesia purposes. The districts were instructed to proceed systematically with the collection and examination of chloroform in tin containers. Several seizures of the decomposed product were effected. Some of the leading manufacturers took steps to withdraw immediately from the market all of their chloroform that had been put up in tin containers. The cause of the deterioration of the chloroform has not been definitely ascertained, but it is thought that it may be due to the tin containers. The United States Pharmacopœia specifies that chloroform shall be packed in glass.

*Eggs.*—Continued attention was given by all inspection districts to the shipment into interstate commerce of decomposed shell eggs. Much work has been done by the bureau in previous years to educate shippers to candle eggs and reject as near to the point of production as possible those which showed signs of deterioration or spoilage. It has been the practice for country stores to buy small lots of eggs and hold them without refrigeration for several days before shipment in order to accumulate larger lots. When the eggs reach the large centers they are candled and the shipper is paid only for the good eggs. However, the off eggs not infrequently are later sold to the retail trade and then to consumers. If the eggs are candled and the off eggs rejected by the country store, the transportation charges are saved and there is little chance that the off eggs will reach consumers. As a result of the educational work of the bureau and of State officials, a larger and larger proportion of the shell eggs are being candled before shipment. Regulatory action has been taken in those cases where shippers did not heed the warnings of the department. Several seizures have been made and a number of prosecutions instituted. The inspection work during this year indicated that there has been a marked improvement in the quality of the shell eggs shipped into interstate commerce in several sections of the country, but need for further work is indicated in other sections.

The central district has inspected the sanitary conditions and quality of eggs used in a number of plants where broken eggs are packed and frozen for use by hotels and bakers. Appropriate action will be taken in those instances where the frozen-egg products shipped into interstate commerce violate the provisions of the food and drugs act.

*Fish.*—The Food Administration during the war encouraged the use of fresh fish and greatly stimulated the use of this wholesome food. The Bureau of Chemistry has done much work to improve the methods of handling, packing, and shipping fresh fish so they will reach inland consuming centers in a good condition. As a result larger quantities of fresh fish are being shipped into interstate commerce each year. The eastern and central districts have given considerable attention during the year to seeing that fish shipped into interstate commerce is not contaminated or decomposed through insanitary handling, that misbranding as to the variety of fish is corrected, and that the quantity of contents of fish in package form is correctly stated. A survey has been made of the fish industry of the Great Lakes and of the Atlantic coast, particularly that of New England. Regulatory action has been taken when necessary to correct violations of the law.

Several carload shipments of spoiled canned salmon from the Pacific coast were seized in the central and eastern districts on information furnished by the western district. Fifteen thousand cases of spoiled salmon had been exported from Seattle, Wash., in 1920 to Vancouver, British Columbia, to escape seizure by the

Federal authorities. At the request of the chief of the Seattle station the food officials of Vancouver kept the salmon under surveillance. It was reshipped in 1921 to cities in the central and eastern parts of the United States. The Seattle station ascertained the destination of the cars and so advised the central and eastern inspection districts. The food officials of Tennessee rendered most valuable assistance in locating and effecting seizure of the cars of the spoiled salmon shipped to that State.

*Other sea food.*—Work on oysters is a major project in the eastern district where a very large proportion of the oysters consumed in the United States is produced. The central and western districts also conduct work on oysters, but the quantity of oysters produced in those districts is relatively small. The three types of violation encountered in connection with fresh oysters are pollution, adulteration with water, and short measure. Pollution of oysters may be caused by the condition of the water from which they are taken, which in some places is polluted with sewage, or from insanitary practices in shucking and handling. The most effective control of pollution from the beds from which the oysters are taken consists in making a sanitary survey of the various commercial oyster beds and permitting oysters to be taken only from beds which are not polluted. Cooperative work on the part of the Public Health Service, Federal, State, and municipal food officials has made it possible to check commerce in oysters from polluted beds. Very great improvement has been made in the sanitary conditions under which oysters are shucked and handled. The most recent reports from the eastern district show that the shipment of polluted oysters from that section has been practically abandoned, and that the practice of adulterating with water and shipping short-measure oysters has been greatly restricted, being confined largely to a few concerns against whom prosecutions are pending.

Equally effective work was done during the year in checking the shipment of scallops adulterated with water. Large quantities of scallops are shipped from North Carolina to the eastern cities. Through a process of soaking in fresh water the scallops are made to absorb water and so increase in bulk. Through the cooperative efforts of the eastern inspection district and the North Carolina Fisheries Commission this practice has been practically discontinued.

Attention was given during the year to controlling the shipment of short-weight and misgraded crab meat. This industry is centered around Chesapeake Bay and its tributaries. A survey showed that sanitary conditions in the packing houses are good, but that keen competition and relatively high prices of the product led a number of shippers to pack short-weight cans and to misgrade the product. As a result of work by the eastern district, which led to some prosecutions, a marked improvement was noted during the year in this industry.

*Jams and jellies.*—Considerable attention was given during the year by all inspection districts and by a staff laboratory in Washington to jams and jellies and especially to the use of added pectin. By the use of added pectin and water it is possible to make a relatively large quantity of jelly with a comparatively small quantity of fruit. The practice of selling jams and jellies made with added pectin and a small quantity of fruit in competition with products in which fruit is the chief ingredient has to a considerable extent demoralized the trade and checked the sale of true jams and jellies. Progress has been made, but additional work is necessary to control this practice.

*Salad oils.*—Much work was done during the year to prevent the adulteration and misbranding of vegetable salad oils, especially in and about New York. A number of dealers have persistently mixed olive oil with cheaper vegetable oils and sold the mixture as olive oil. There has also been a widespread practice of selling short-volume oils. These practices were materially checked during the year by a campaign conducted by the eastern district. Eighty-seven criminal prosecutions were instituted and 160 seizures effected.

*Apples.*—Through the cooperative efforts of the eastern district and the New York apple inspection service the shipment of apples from New York misbranded as to grade was checked. The New York law requires that apples in barrels be labeled as to grade. Some shippers were found to be shipping apples into interstate commerce misbranded as to grade.

*Quantity of contents.*—The food and drugs act requires that all food in package form shipped within its jurisdiction shall bear on the labels of the packages a plain and conspicuous statement of the quantity of contents. All the inspection districts performed much work both along educational lines to bring to the attention of shippers, particularly small shippers of fruits and vegetables, this requirement of the law, and along regulatory lines in a great variety of food products to check misbranding as to quantity of contents. Improvements were effected during the year in both lines of work. A bulletin on "Volume variation of bottled foods" was published.

In addition to the specific products mentioned, much work was done during the year on other food products. The following table shows the number of seizures effected and the criminal prosecutions instituted during the year:

| Product. | Prosecutions. | Seizures. | Total. |
|---|---|---|---|
| Alimentary paste | 9 | 4 | 13 |
| Apple products | 11 | 6 | 17 |
| Beverages | 9 | 6 | 15 |
| Butter | 25 | 9 | 34 |
| Canned vegetables | 3 | 16 | 19 |
| Candy | 11 | 4 | 15 |
| Chocolate and cocoa | 8 | 10 | 18 |
| Colors, food | ........ | 5 | 5 |
| Cider | 3 | ........ | 3 |
| Drugs, crude | 2 | ........ | 2 |
| Eggs: | | | |
| Frozen | 1 | 4 | 5 |
| Shell | 41 | 8 | 49 |
| Feeds | 119 | 38 | 157 |
| Fish, canned | 5 | 34 | 39 |
| Shellfish: | | | |
| Clams | 6 | 8 | 14 |
| Crab meat | 10 | 2 | 12 |
| Oysters | 25 | 2 | 27 |
| Scallops | 21 | 23 | 44 |
| Flavors | 21 | 10 | 31 |
| Flour | 1 | 27 | 28 |
| Fruits | 25 | 83 | 108 |
| Gelatin | ........ | 3 | 3 |
| Ice cream and cones | 6 | ........ | 6 |
| Jams, preserves | 1 | 11 | 12 |
| Meat | ........ | 5 | 5 |
| Milk, condensed | ........ | 3 | 3 |
| Miscellaneous foods | 1 | 7 | 8 |
| Molasses | 2 | 2 | 4 |
| Mustard | ........ | 6 | 6 |
| Nuts | 1 | 10 | 11 |
| Oils, salad | 87 | 160 | 247 |
| Pie fillings | 8 | 1 | 9 |
| Remedies | 11 | 458 | 469 |
| Sauerkraut | ........ | 4 | 4 |
| Spices | 6 | 37 | 43 |
| Sirup | 4 | 7 | 11 |
| Tea | 2 | 11 | 13 |
| Tomato products | 15 | 20 | 35 |
| Vegetables | 15 | 2 | 17 |
| Vinegar | 42 | 77 | 119 |
| Water | 3 | 10 | 13 |
| | 560 | 1,133 | 1,693 |

### Imported Food and Drugs.

Under the food and drugs act inspection is maintained of foods and drugs imported into the United States. The act provides that any article of food or drug offered for entry into the United States that is adulterated or misbranded under the act, or is otherwise dangerous to the health of the people of the United States, or that is prohibited or restricted in the country in which made or from which exported, shall be refused admission to this country.

This provision of the act throws a great volume of work upon the bureau, especially in New York, through which port a large proportion of the imported foods and drugs is entered. It is impossible with the limited personnel available to examine all shipments of imported foods and drugs. Attention is therefore directed to shipments of the articles that previous examinations have indicated are most likely to be adulterated. It is highly important that all shipments of each article being inspected during a given period be examined in order that the goods of every importer may be handled uniformly. It is also highly important that the work of examination be done promptly in order to prevent the accumulation of undue storage charges upon consignments. Progress was made during the year in systematizing and speeding up the work in New York, but the force available is entirely inadequate to include in the examinations all the consignments that should receive attention. The force of analysts at New York was reduced during the war, since the volume of imports was greatly lessened during that period, and appropriations for the work will not permit the force to be restored to an adequate size.

### Food Standards.

The formulating of food standards and definitions is of the greatest importance in the effective enforcement of the food and drugs act. The Bureau of Chemistry works in close cooperation with the joint committee on definitions and standards which is composed of representatives of the United States Department of Agriculture, the Association of Official Agricultural Chemists, and the Association of American Dairy, Food, and Drug Officials. During the fiscal year 1922 standards and definitions were adopted by the joint committee for the following food products: Breads, cocoa products, butter, ginger ale and ginger-ale flavor, and evaporated milk.

## THE TEA INSPECTION ACT.

Tea is subject to both the food and drugs act and the tea inspection act. All teas imported into the United States are inspected at time of entry and only those teas which come up to the United States standard, both as to purity and quality, are admitted. A larger percentage of tea than usual was rejected during the fiscal year ending June 30, 1922. The rejections for quality were due mainly to damaged teas, and the rejections for purity were due to impurities in certain China green teas offered for entry during the last six months of the year.

Eleven seizures were effected and two prosecutions instituted under the food and drugs act for the shipment into interstate commerce of tea in violation of that act.

# REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

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United States Department of Agriculture,
Bureau of Soils,
*Washington, D. C., September 12, 1922.*

Sir: I have the honor to transmit herewith a report covering the operations of the Bureau of Soils for the fiscal year ended June 30, 1922.

Respectfully,

Milton Whitney,
*Chief of Bureau.*

Hon. H. C. Wallace,
*Secretary of Agriculture.*

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## SOIL SURVEY.

During the fiscal year ended June 30, 1922, detailed soil surveys were completed or begun in 69 different counties or areas located in 29 States. The area surveyed in these projects was 27,337 square miles, or 17,495,680 acres. Reconnaissance surveys were conducted in Michigan, Minnesota, Montana, and Texas, covering a total area of 18,314 square miles, or 11,720,960 acres.

The total area covered by detailed surveys from the inception of the work to and including June 30, 1922, amounts to 602,743 square miles, or 385,755,520 acres, and by reconnaissance surveys 534,600 square miles, or 342,144,000 acres. This is a total of 1,137,343 square miles or slightly more than one-third of continental United States. There are in some of the Western States large areas of mountain lands and of deserts, where there is no immediate prospect of irrigation or of grazing, and for which there will likely be no need of soil surveys.

The following tables show the areas surveyed during the fiscal year just closed and the total area surveyed in each State up to the present time:

Table 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1922.*

DETAILED.

| State. | Area. | Area surveyed. | |
|---|---|---|---|
| | | Square miles. | Acres. |
| Alabama | Choctaw County | [1] 192 | 122,880 |
| | Crenshaw County | [1] 230 | 147,200 |
| | Greene County | 170 | 108,800 |
| Arkansas | Pulaski County | [1] 570 | 364,800 |
| California | Eureka area | 392 | 250,880 |
| | Gilroy-Hollister area | 106 | 67,840 |

[1] These figures do not include portions of these areas surveyed in previous years.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1922*—Continued.

DETAILED—Continued.

| State. | Area. | Area surveyed. | |
|---|---|---|---|
| | | Square miles. | Acres. |
| California | Lancaster area | 525 | 336,000 |
| | Palo Verde area | 416 | 266,240 |
| Colorado | Rocky Ford area | [1] 62 | 39,680 |
| Georgia | Jenkins County | 241 | 154,240 |
| | Muscogee County | 235 | 150,400 |
| Idaho | Twin Falls area | [1] 123 | 78,720 |
| Indiana | Clay County | 361 | 231,040 |
| | Gibson County | 486 | 311,040 |
| | Monroe County | 118 | 75,520 |
| Iowa | Benton County | [1] 578 | 369,920 |
| | Delaware County | 105 | 67,200 |
| | Des Moines County | 409 | 261,760 |
| | Floyd County | 107 | 68,480 |
| | Greene County | 574 | 367,360 |
| | Grundy County | 501 | 320,640 |
| | Jasper County | 730 | 467,200 |
| | O'Brien County | [1] 451 | 288,640 |
| | Page County | 531 | 339,840 |
| Louisiana | Washington Parish | [1] 458 | 293,120 |
| Maryland | Dorchester County | 576 | 368,640 |
| | Wicomico County | [1] 175 | 112,000 |
| Massachusetts | Worcester County | 600 | 384,000 |
| Michigan | Kalamazoo County | 210 | 134,400 |
| | Ottawa County | 527 | 337,280 |
| Minnesota | Cloquet area | 247 | 158,080 |
| Mississippi | George County | [1] 336 | 215,040 |
| | Perry County | 219 | 140,160 |
| | Rankin County | 116 | 74,240 |
| Missouri | Andrew County | 428 | 273,920 |
| | Mississippi County | 413 | 264,320 |
| Nebraska | Antelope County | [1] 653 | 417,920 |
| | Boone County | 692 | 442,880 |
| | Garden County | [1] 453 | 289,920 |
| | Jefferson County | 578 | 369,920 |
| | Nance County | 100 | 64,000 |
| | Perkins County | 886 | 567,040 |
| New Jersey | Bergen area | 114 | 72,960 |
| | Salem area | 331 | 211,840 |
| | Trenton area | [1] 139 | 88,960 |
| New York | Cayuga County | [1] 407 | 260,480 |
| | Genesee County | 335 | 214,400 |
| North Carolina | Cherokee County | 454 | 290,560 |
| | Cumberland County | [1] 320 | 204,800 |
| | Sampson County | 307 | 196,480 |
| North Dakota | McHenry County | [1] 714 | 456,960 |
| Oregon | Clackamas County | [1] 1,292 | 826,880 |
| Pennsylvania | Greene County | 574 | 367,360 |
| South Carolina | Lexington County | [1] 305 | 195,200 |
| South Dakota | Grant County | 180 | 115,200 |
| | McCook County | [1] 237 | 151,680 |
| | Union County | 452 | 289,280 |
| Tennessee | Bedford County | [1] 100 | 64,000 |
| | Henry County | [1] 408 | 261,120 |
| Texas | Coleman County | [1] 713 | 456,320 |
| | Dickens County | 446 | 285,440 |
| | Harris County | [1] 800 | 512,000 |
| | Henderson County | 108 | 69,120 |
| | Reeves County | [1] 1,482 | 948,480 |
| Utah | Uintah Valley area | 153 | 97,920 |
| West Virginia | Tucker County | 405 | 259,200 |
| Wisconsin | Green County | [1] 305 | 195,200 |
| | Green Lake County | 247 | 158,080 |
| | Ozaukee County | [1] 129 | 82,560 |
| Total | | 27,337 | 17,495,680 |

[1] These figures do not include portions of these areas surveyed in preceding years.

TABLE 2.—*Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1922, and the areas previously reported.*

DETAILED.

| State or Territory. | Work during 1922 (square miles). | Work previously reported (square miles). | Total. | |
|---|---|---|---|---|
| | | | Square miles. | Acres. |
| Alabama | 592 | 48,250 | 48,842 | 31,258,880 |
| Arizona | | 1,738 | 1,738 | 1,112,320 |
| Arkansas | 570 | 12,945 | 13,515 | 8,649,600 |
| California | 1,439 | 21,091 | 22,530 | 14,419,200 |
| Colorado | 62 | 2,976 | 3,038 | 1,944,320 |
| Connecticut | | 1,704 | 1,704 | 1,090,560 |
| Delaware | | 2,276 | 2,276 | 1,456,640 |
| Florida | | 12,206 | 12,206 | 7,811,840 |
| Georgia | 476 | 27,244 | 27,720 | 17,740,800 |
| Idaho | 123 | 8,628 | 8,751 | 5,600,640 |
| Illinois | | 6,770 | 6,770 | 4,332,800 |
| Indiana | 965 | 11,981 | 12,946 | 8,285,440 |
| Iowa | 3,986 | 24,815 | 28,801 | 18,432,640 |
| Kansas | | 9,456 | 9,456 | 6,051,840 |
| Kentucky | | 5,020 | 5,020 | 3,212,800 |
| Louisiana | 458 | 15,139 | 15,597 | 9,982,080 |
| Maine | | 2,197 | 2,197 | 1,406,080 |
| Maryland | 751 | 8,478 | 9,229 | 5,906,560 |
| Massachusetts | 600 | 2,880 | 3,480 | 2,227,200 |
| Michigan | 737 | 6,227 | 6,964 | 4,456,960 |
| Minnesota | 247 | 5,301 | 5,548 | 3,550,720 |
| Mississippi | 671 | 25,466 | 26,137 | 16,727,680 |
| Missouri | 841 | 33,702 | 34,543 | 22,107,520 |
| Montana | | 882 | 882 | 564,480 |
| Nebraska | 3,362 | 28,989 | 32,351 | 20,704,640 |
| Nevada | | 235 | 235 | 150,400 |
| New Hampshire | | 1,411 | 1,411 | 903,040 |
| New Jersey | 584 | 7,757 | 8,341 | 5,338,240 |
| New Mexico | | 596 | 596 | 381,440 |
| New York | 742 | 20,670 | 21,412 | 13,703,680 |
| North Carolina | 1,081 | 32,539 | 33,620 | 21,516,800 |
| North Dakota | 714 | 14,401 | 15,115 | 9,673,600 |
| Ohio | | 10,305 | 10,305 | 6,595,200 |
| Oklahoma | | 6,540 | 6,540 | 4,185,600 |
| Oregon | 1,292 | 6,877 | 8,169 | 5,228,160 |
| Pennsylvania | 574 | 16,147 | 16,721 | 10,701,440 |
| Porto Rico | | 330 | 330 | 211,200 |
| Rhode Island | | 1,085 | 1,085 | 694,400 |
| South Carolina | 305 | 22,757 | 23,062 | 14,759,680 |
| South Dakota | 869 | 2,261 | 3,130 | 2,003,200 |
| Tennessee | 508 | 9,559 | 10,067 | 6,442,880 |
| Texas | 3,549 | 35,222 | 38,771 | 24,813,440 |
| Utah | 153 | 2,266 | 2,419 | 1,548,160 |
| Vermont | | 1,175 | 1,175 | 752,000 |
| Virginia | | 9,713 | 9,713 | 6,216,320 |
| Washington | | 10,752 | 10,752 | 6,881,280 |
| West Virginia | 405 | 17,362 | 17,767 | 11,370,880 |
| Wisconsin | 681 | 18,230 | 18,911 | 12,103,040 |
| Wyoming | | 855 | 855 | 547,200 |
| Total | 27,337 | 575,406 | 602,743 | 385,755,520 |

RECONNAISSANCE.

| State or Territory. | Work during 1922 (square miles). | Work previously reported (square miles). | Total square miles. | Total acres. |
|---|---|---|---|---|
| Alaska | | 31,915 | 31,915 | 20,425,600 |
| Arkansas-Missouri | | 58,000 | 58,000 | 37,120,000 |
| California | | 32,135 | 32,135 | 20,566,400 |
| Kansas | | 39,960 | 39,960 | 25,574,400 |
| Michigan | 1,322 | | 1,322 | 846,080 |
| Minnesota | 752 | | 752 | 481,280 |
| Montana | 5,315 | | 5,315 | 3,401,600 |
| Nebraska | | 53,064 | 53,064 | 33,960,960 |
| North Dakota | | 39,240 | 39,240 | 25,113,600 |
| Ohio | | 41,420 | 41,420 | 26,508,800 |
| Pennsylvania | | 41,405 | 41,405 | 26,499,200 |
| South Dakota | | 41,400 | 41,400 | 26,496,000 |
| Texas | 10,925 | 110,207 | 121,132 | 77,524,480 |
| Washington | | 13,115 | 13,115 | 8,393,600 |
| Wisconsin | | 14,425 | 14,425 | 9,232,000 |
| Total | 18,311 | 516,286 | 534,600 | 342,144,000 |

The Soil Survey is contributing its share to the development of American agriculture by placing in the hands of the people detailed knowledge of the soils of the country. Its work is both scientific and practical in its scope. It is fundamental in character, and its value in this respect is clearly recognized, as is shown by the increasing demand for soil surveys from investigators working in almost every field of scientific agriculture. The introduction of agricultural instruction in the common schools and the extension of agricultural schools has also created a demand for information as to the soils and their relation to agricultural conditions in different parts of the country, which is supplied in the Soil Survey reports.

Prominent among demands for soil surveys, in addition to those from the cooperating States, are those coming from development companies interested in opening up large tracts of cut-over land to settlement, from the home seeker or farmer looking for a new location, from road engineers, land banks, and large loan companies.

The Soil Survey is classing, making an inventory of, and recording the facts concerning the soils of this country. Thus the soil-survey work is the basis for the experimentation of the various State agricultural experiment stations. As a result of the classification of the soils by the Soil Survey, varietal and fertilizer tests are being established on the large and important soil types of the United States. That the soil type possesses individual characteristics is becoming more and more recognized by the agriculturist, county farm adviser, and extension-service director. The peculiarities of the various soils must be considered if we are to make the greatest progress in plant breeding and selection, in fertilizer practice, in cultivation—in fact, in all work looking to improvement of cultivated crops.

Most of the work of the Soil Survey is carried on in cooperation with State organizations, such as agricultural colleges, experiment stations, departments of agriculture, and geological surveys. During the fiscal year the following States contributed funds to help carry on the work: Alabama, Arkansas, California, Georgia, Idaho, Indiana, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wisconsin. The bureau has been unable to meet fully the demands of the States for cooperative work and, in addition, to extend its surveys in noncooperating States to the extent necessary to proper progress in the construction of a soil map of the United States.

Besides cooperating with the States listed, the bureau has cooperated with the War Department in determining the value of land taken for camp sites, with the Office of Indian Affairs, the Reclamation Service, the Department of Justice, the Bureau of Standards, and with the Bureau of Plant Industry and the Forest Service of this department. About the usual amount of such cooperative work was done.

Much advice and information by correspondence was given during the year by the section of soil information. A large number of miscellaneous samples were examined in connection with this service. Many persons who contemplate the purchase of land or who have recently acquired land seek information regarding the character of the soils in their prospective or actual holdings and concerning the kinds of crops which may be most profitably produced thereon. This section has also assisted in the preparation of exhibits to be shown at a number of the more important agricultural fairs.

Science is international rather than national. The results attained in one country may have very great influence on the workers in other countries, so that it is desirable that the workers along the same lines in different countries should keep in touch with each other. In order that this be done in soil-survey work, and in order that the soils in the United States might be compared with the soils in Europe, an employee of the bureau was sent abroad for three months, April 1 to July 1. He visited Czechoslovakia, Hungary, Rumania, Yugoslavia, Italy, Greece, Germany, and England, studying and collecting samples of typical soils in parts of those countries. Most of the samples collected have been received in the bureau and will be taken up for such analytical work as seems advisable.

Calls on the Soil Survey by the Department of Justice for expert testimony relative to changing State boundaries and also as to the value of land for camp sites were made during the year. Representatives of the Soil Survey made a detailed map of the soils of the Red River bottoms, in the vicinity of the Burkburnett oil field, for the purpose of showing the process by which the bottoms were built up, this fact having an important bearing on the settlement of a boundary dispute between Texas and Oklahoma. The question as to whether the land in controversy was formed by accretion or by avulsion would practically decide the issue, and consequently extremely detailed soil maps, profile maps of deep borings, and careful mechanical analyses of material were necessary in order to determine the presence or absence of a gradation from coarse to finer alluvial sediments from the edge of the bottoms toward the uplands.

Testimony of experts of the Soil Survey was credited with having saved the Government approximately $500,000 in settlement of the Fort Bragg land cases. In one case the court ordered the appraisers' valuation changed from $520,000 to $311,000, and many other cases were settled in about the same proportion.

## CHEMICAL INVESTIGATIONS.

The research work of the chemical division, as in the preceding year, was confined largely to the investigation of soil colloids, and it is felt that distinct progress has been made in several phases of this investigation.

By altering somewhat the methods of treatment, the bureau has been able to extract a much larger part of the total colloidal matter in the soil than had hitherto been found possible. It has therefore been able to confirm the conclusion, arrived at by less direct methods, that some soils may contain 50 per cent or more of truly colloidal matter. In the case of a very heavy clay soil 42 per cent of colloidal matter was actually isolated.

Heretofore the general conception among soil scientists has been that while the colloidal matter is one of the most important constituents of the soil, it forms only a relatively small part of the whole soil—less than 2 per cent in most cases. If soils contain 5 to 50 per cent of colloid instead of 1 to 2 per cent, it will obviously be necessary to revise our conception of the soil, and it may be profitable to rework some of the older lines of soil investigation in the light of this new knowledge.

It seems impossible to extract all the colloidal matter from a soil, and it is a very time-consuming operation to extract any considerable part of it. The bureau, therefore, has attempted to devise indirect methods for determining the amounts of colloids in different soils. The absorption methods tested thus far probably all give a very fair approximation of the colloidal content of soils. The method depending upon the absorption of water vapor seems particularly likely to be one of general usefulness. In fact, in cooperative work with the Geological Survey this method was used for indicating the approximate colloidal content of some 50 samples of deep-sea mud. The results checked up well with other evidence concerning the quantity of colloid present. A description of this method will shortly be published in the Journal of Physical Chemistry.

In order to perfect the methods of determining soil colloids it has been necessary to investigate many of the properties of the colloids, such as the degree to which they are affected by aging and by heat, their similarity to synthetic inorganic gels, and their absorptive capacities as compared with those of finely ground minerals.

It is expected that during the coming year the work that has been accomplished on methods of determining soil colloids can be presented for publication. A report on the investigation concerning the chemical composition and formation of the soil colloids will also be completed. Results regarding absorption by colloidal and noncolloidal soil constituents are now in process of publication.

As in past years, about half the time of the division has been devoted to making complete chemical analyses of soils for the Soil Survey and analyzing samples for other branches of the Government. A large number of miscellaneous samples submitted for identification or determination of one or two constituents were also examined.

The identification of certain soil constituents and the research work in many instances has been greatly facilitated by the use of petrographic methods of examination. In the course of this work it has been necessary from time to time to gather together the optical constants of practically all the common inorganic salts. By the arrangement of these constants in appropriate tabular form it is now possible to identify any of these inorganic salts within a relatively few minutes. These tables are being published with the idea of facilitating the work of other chemists and of encouraging the adoption of petrographic methods where they possess marked advantages over chemical analysis.

## FERTILIZER INVESTIGATIONS.

During the last fiscal year the bureau has continued its general fundamental work to develop our resources in fertilizer materials. It has furnished to farmers and others interested in fertilizers technical information regarding fertilizers, lime, and manure, their sources, supply, manufacture, purchase, and mixing, and has advised on many problems bearing on fertilizers that have arisen in the various departments of the Government. Cooperative work with the other departments of the Government and with other bureaus of this department has been continued, more especially with the Fixed Nitrogen Research Laboratory. The several investigations which have to do with concentrated fertilizers, nitrogen, phosphoric acid, and potash will be discussed under appropriate heads. The bureau has more fully equipped its laboratories and buildings at Arlington Experimental Farm, and is now prepared both with facilities and men to do research work on a semifactory scale.

## CONCENTRATED FERTILIZERS.

Attention has been directed in previous reports to new developments in the fertilizer industry which call for the preparation of fertilizer mixtures of higher concentration than those formerly used. The Haber and other processes for fixing nitrogen and the volatilization method of preparing phosphoric acid from run-of-mine phosphates all yield materials as finished products of different composition and higher concentration than those ordinarily used in the manufacture of fertilizers. The study of concentrated fertilizers and fertilizer materials was therefore undertaken, not only as a necessary step in the development of new sources of fertilizers, but also with a view to reducing the cost of fertilizers by bringing about a decrease in the cost of handling and transportation.

The ammonia recovered in the fixing of nitrogen is not suited for direct use in fertilizers, but when this is neutralized with phosphoric acid a product is obtained which contains two of the three essential constituents of fertilizers and of such concentration that the content of both amounts to a total of 74 per cent, or four times the concentration of the average fertilizer.

By modifying the process so as to include the use of commercial potassium chloride as well as phosphoric acid and ammonia, it has been found that a product of corresponding concentration may easily be obtained which contains all three of the essential constituents of fertilizers. The chemical and physical properties of this material, which consists of a mixture of ammonium and potassium phosphate, makes it admirably suited as a medium for transporting the fertilizing elements or for increasing the concentration of other fertilizer mixtures.

Since phosphoric acid is required in the preparation of these materials, it follows that the commercial possibilities in the preparation of concentrated fertilizers depends on the cost of producing phosphoric acid. The methods that have been devised by the bureau for the preparation of this acid yield a product of most suitable concentration for the production of concentrated fertilizers, and steps are now being taken by outside concerns to test out the possibilities of the processes outlined in this and other reports. Samples of materials already produced, together with a number that have been prepared by the Bureau of Soils, were exhibited at the congressional hearings on the Muscle Shoals propositions and attracted much attention.

Considerable difficulty was at first experienced in the course of this work, owing to a lack of suitable methods of analysis. It was found possible, however, to devise simple and accurate methods of special application to the materials proposed for concentrated fertilizers and a description of the methods has been given to the scientific press.

## NITROGEN FIXATION.

One of the chief difficulties in the operation of the Haber process has been the complete removal of ammonia from the gaseous mixture. The bureau's work on this phase of the problem has developed a method that, it is believed, is superior to any of the methods employed heretofore. A small unit designed for this process has been constructed and is being operated in connection with the catalyst testing plant of the Fixed Nitrogen Research Laboratory. A further improvement on the process has been projected and is being tried out on an independent unit. These improvements, if successful, will not only remove the ammonia more completely from the gases, but can be adapted to the character of catalyst being used, so that even very sensitive catalysts will not deteriorate through the presence of poisonous substances in the return gases. The success of the method will mean a longer life for the catalyst and greater efficiency in operation.

## PHOSPHATE INVESTIGATIONS.

During the year investigations have been continued on the volatilization of phosphoric acid from run-of-mine and low-grade phosphates, using a fuel-fed furnace and collecting the acid by means of the Cottrell electrical precipitator. Considerable progress has been made in this investigation and a number of reports and papers have been published in the scientific and technical press. The feasibility of briquetting phosphates from various phosphate deposits for use in this furnace process has been given close study, and experiments show that many deposits of phosphate formerly considered unfit for fertilizer manufacture are of an almost ideal composition for the smelting or furnace process of manufacture, wherein advantage is being taken of certain of these impurities to further the chemical reactions involved. A furnace plant of semicommercial size more fully equipped and with better auxiliary apparatus has been erected at Arlington Experimental Farm, and the numerous mechanical problems encountered are gradually being worked out. The changes in design and construction of certain units in this plant which must be made from time to time involve careful study and make progress somewhat slow, but the results so far obtained hold out great promise of eliminating much waste, utilizing more fully our phosphate resources, and of lowering the price of fertilizer to the ultimate consumer. Phosphate miners, fertilizer manufacturers, and farm organizations are following this work with keen interest.

It has been found that when the phosphoric acid obtained by the volatilization process is collected at an elevated temperature phosphoric acid of such high concentration is obtained that, on cooling, it crystallizes to a solid mass. By centrifuging these crystals and recrystallizing, if necessary, a product can easily be obtained of much greater purity than any heretofore offered on the market. This fact suggested the possibility of manufacturing a high-grade acid as a by-product which would contribute to the economy of producing lower grade phosphoric acid for fertilizer purposes. A study has been made of the best conditions for the production of both grades of acid, and the process is now being tried out by commercial interests at Anniston, Ala.

A bulletin describing the work of this bureau on phosphoric acid and phosphates is now nearing completion. This report describes and discusses the various phosphate fertilizers, both natural and manufactured, which are available for agricultural purposes, compares and describes methods of manufacture, and gives in detail the results of the research work of this bureau on methods of producing phosphoric acid suitable for fertilizer use.

## POTASH.

During the summer of 1919 the attention of this bureau was directed to extensive injury to crops by the use of fertilizers containing borax. The evidence collected at that time pointed to borax in the potash from Searles Lake as the primary cause of the injury, and as a precautionary step a careful check has since been kept on the purity of the potash salts from this source. Analyses made at intervals of the products produced since the adoption in 1919 of a new process for the purification of the potash show a borax content ranging from 0.59 to 0.07 per cent, as compared with a maximum of about 20 per cent in the salts produced by the original process. These results show that the borax in the potassium chloride now produced at Searles Lake compares favorably with that found in sodium nitrate, a nitrogen carrier long used in fertilizing the crops of this country.

Borax has been the only deleterious substance found in American potash, and the quality of the materials produced since 1919 shows that the producers have met the requirements of the Department of Agriculture and that there no longer exists the former danger to crops from the presence of borax in fertilizers.

## SOIL PHYSICS.

A great advance has been made in the study of the physical composition of soils. Much of the material that previously has been classed in the sand and silt groups has been found to be made up of colloidal aggregates. Work looking to the development of a new method that will take into account these facts has been started. Results of analysis according to the new method should express the percentage of colloid present in the soil. This will be exceedingly valuable, because it has been long known that the colloidal material in a soil was perhaps the most significant portion of its physical composition, though no method was known by which this amount could be determined and expressed in an ordinary analysis. A method should be furnished that will express the colloidal content as a part of the mechanical analysis.

Work has been continued in studying the relation of colloidal content to the mechanical composition of the rest of the soil. Briquets of selected material mixed with colloid are tested for their breaking strength. These tests have shown the great influence of colloid upon the bearing strength of soils and have indicated that the optimum condition for cultivation is closely related to the colloidal content of the soil. These relations are being investigated for an expression that may be generally applicable.

Routine mechanical analyses of soil-survey samples have been continued. In addition an unusual demand has been made on the division for outside work in the examination of sea-bottom samples for the United States Geological Survey, material used in building levees on the Mississippi River, foundation materials from many sources, reclamation lands, and court cases involving origin of the soil. These, as examples, show the wide applicability of the mechanical analysis.

The regular work on the design and construction of apparatus has been continued and a number of pieces of such apparatus completed for use in our laboratories.

# REPORT OF THE ENTOMOLOGIST.

United States Department of Agriculture,
Bureau of Entomology,
*Washington, D. C., August 22, 1922.*

Sir: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1922.

L. O. Howard,
*Entomologist and Chief of Bureau.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

## DECIDUOUS-FRUIT INSECT INVESTIGATIONS.

Investigations of deciduous-fruit insects have been carried out under the direction of Dr. A. L. Quaintance as formerly.

The Japanese beetle.—Work against the Japanese beetle has been prosecuted as heretofore in cooperation with the New Jersey and Pennsylvania State Departments of Agriculture. Much additional information concerning the life history, habits, and injurious character of the pest has been obtained in the several lines of work, but it has been spreading and threatens to become a pest of first-class and widespread importance.

The Federal Quarantine No. 48, the New Jersey State quarantine, and the Pennsylvania State quarantine have been in effect, the State quarantines supplementing the Federal quarantine for intrastate traffic. As heretofore, the enforcement of State quarantines has been delegated to bureau authorities, who cooperate with the Federal Horticultural Board. Special attention has been given to the inspection and certification of vegetable products. During the season of 1921 some 205,498 baskets of sweet corn were inspected and more than 5,000 beetles were removed from within the tips of the corn during this inspection. This is a marked increase over inspection work done during the previous year and also in the number of beetles found.

Scouting to determine the limits of infestation was carried on throughout the summer of 1921, involving some 400 square miles, with the result that approximately 213 square miles in New Jersey and approximately 57 square miles in Pennsylvania were found to be infested.

In the investigational work on the Japanese beetle, studies of arsenical insecticides have been continued. Although it has been repeatedly demonstrated in the course of the work that ordinary arsenical sprays are not effective against the beetles at the strengths usually employed, there seems reason to believe that the use of arsenate of lead at heavier doses than commonly recommended will kill from 50 to 60 per cent of the beetles. Other stomach poisons are under investigation, especially metallic cyanids, such as nickel and copper. Attention is also being given to organic chemicals in the hope that a substitute for arsenical insecticides may be found. Contact insecticides against the adults have been experimented with for several seasons, and it has been found that a contact insecticide of sodium-soy bean soap will kill approximately 90 per cent of the beetles. Fortunately this soap can be used on practically all types of foliage attacked without injurious results.

Additional studies have been made of possible methods of destroying the Japanese beetle grubs in the soil. Paradichlorobenzene probably gave the best results against the larvæ in sod. When used at the rate of 300 pounds per acre at a depth of approximately 1 inch, with the drills 4 inches apart, it killed approximately 75 per cent of the grubs. The cost of such treatment is high, and additional studies are being made. Greenhouse soil has been the subject of special investigation, in view of the necessity of grub-free soil for potting purposes in order to avoid danger of dissemination of the grubs in the shipment of potted plants. It was found that carbon disulphid is a cheap and efficient material for fumigating potting soil. For best results not less than 1 pound to a cubic yard of soil must be used, with an exposure of 48 hours at a temperature above 50° F. Soil up to almost any quantity may be treated by this method with assurance that the grubs will be killed. Thoroughgoing experiments to determine the possibility of vacuum and pressure for the destruction of the grubs in the soil have not shown favorable results. Tests of various arsenicals as soil insecticides are under way. Arsenate of lead has proved to be the best and will kill the grubs. Plants vary in their resistance to this treatment and further studies are necessary.

A paper giving detailed information on the feeding habits of the beetle has been prepared for publication, as well as a paper on the feeding habits of the larva. It appears that the insect is changing its habits somewhat from season to season in its new environment. This is especially true of the adult beetle. During the season of 1922 the beetles were excessively abundant in the territory infested 3 and 4 years ago, attacking peaches, apples, grapes, and many other plants, including certain shade trees. There is nothing to indicate that the insect has reached its limit of capabilities in this respect.

Studies are in progress to determine the possibilities of destroying the grubs in the soil by cultural practices as carried out in farming and trucking operations.

Suitable equipment has been obtained for making a detailed study of the effect of the removal of the soil from " balled earth " nursery stock, such as conifers. Unless satisfactory methods can be found to kill the grubs under these conditions, nursery interests will suffer, as it would not be safe to ship balled-earth plants.

The search for parasites of the Japanese beetle in Japan has been vigorously prosecuted.

Some 125,000 Japanese beetles infested with a tachinid parasite have been collected in Japan and forwarded to the Riverton, N. J., laboratory, where the parasites have been liberated. Another tachinid or dexiid parasite of the adult beetle has also been found in Japan and in Korea. The agents in Japan are also trying to rear large numbers of a parasitic wasp of the genus Tiphia which they hope to send over soon. In Korea an early-season dexiid and Tiphia parasites of several species have been found, the introduction of which will be attempted as soon as possible. In order to insure the best handling of these parasites, careful attention is being given to their life history and habits as a basis for propagation in large numbers. In addition to this work in Japan, the parasites of related insects in this country are being studied to see if some of them can be made useful against this pest. Still another parasite will be sent from Hawaii.

PEACH INSECTS.—Work has been continued in the suppression of the plum curculio, brown-rot, and scab of peaches in Georgia in cooperation with the Bureau of Plant Industry and the Georgia State Board of Entomology. Continued improvement in the situation has resulted from this work. The harvest of 1922 was exceedingly satisfactory from the growers' standpoint, and in orchards where the bureau's recommendations for spraying, dusting, and other control operations were carried out the fruit was practically free from curculio grubs.

At the urgent request of peach growers in the Sandhill peach district of North Carolina, peach-pest control work was undertaken the present spring in cooperation with the Bureau of Plant Industry and the North Carolina State Department of Agriculture. The spraying and dusting schedule found so effective in Georgia was put in effect in the North Carolina territory with most excellent results.

Considerable attention has also been given to further tests of paradichlorobenzene for the peach borer under varying seasonal conditions and on trees of different ages. It appears that when properly applied this chemical can be utilized for the destruction of the borer on trees 2 to 3 years of age and over, which materially enlarges its range of usefulness and obviates almost entirely the necessity of worming peach trees. Experiments were made in the fall of 1921 to determine the usefulness of paradichlorobenzene for the destruction of the California peach borer on apricot, prune, etc., in the Santa Clara Valley. The results obtained were very gratifying and give hope that the chemical can be used effectively on this serious pest.

APPLE INSECTS.—Studies of the codling moth have been continued along the lines previously followed in the Yakima Valley, Wash., and Rogue River Valley, Oreg., and additional information obtained. The work under way for several seasons in the Ozarks and in north Georgia has been completed, and in the latter State the temporary station closed. Special attention has been given to experimental work with sprays and dusts in orchards to settle many practical points in connection with codling-moth control, such as the comparative merits of spray guns and rods, best type of power machinery to employ, value of stickers or adhesives in spray solutions, and the like. New questions are constantly arising as to spraying and dusting equipment, insecticides, etc., which are of much practical interest to growers. The introduction of codling-moth parasites from the East to the State of Washington has resulted in the establishment there of one species at least. Further attention is being given to the matter of spray residues on harvested apples and pears in Washington and Oregon. The work under way in California, as indicated in the last report, was successfully completed and a report issued. A spray schedule was developed, which, if followed by growers, will obviate almost entirely the presence of spray residues on fruit at harvest time.

A number of other apple insects have been under investigation, as apple leafhoppers, apple maggot, etc. Manuscripts have been submitted giving the results of several seasons' studies of cankerworms and the bud moth. Observations are being made on the red-banded leaf-roller, the false red bug, and the apple and thorn skeletonizer, this latter a rather recently introduced pest.

The San Jose scale is again becoming troublesome in certain parts of the country, and has been especially injurious in apple orchards in the Ozarks. Special attention has been given to control of this insect in bearing orchards at the Bentonville, Ark., laboratory, and material progress made. A new dormant-tree spray has been developed, composed of 2 per cent engine oil thoroughly emulsified with potash-fishoil soap, which has been found to be very effective. In view of its cheapness and ease of application, the treatment was largely adopted by orchardists in preference to lime-sulphur wash and over 1,000 barrels of stock emulsion were used in Benton and Washington Counties during the spring of 1922. No injury to trees has thus far been noted from the use of this material as a dormant spray, although in experimental work a spray containing as much as 10 per cent of the lubricating oil was applied. This same spray at weaker strength, as 1½ per cent, applied alone or in Bordeaux mixture, has given good control of the hatching scales and the newly settled young. It was further ascertained that a spray containing 1 per cent of lubricating oil was about as effective as nicotine sulphate in the control of the green apple aphis and far less expensive. In cooperation with the entomologists of the Arkansas Agricultural Experiment Station, careful biological studies of the San Jose scale in the Ozarks are being made, special attention being directed to the factors resulting in its present unusual abundance and destructiveness as compared with conditions in former years.

NUT INSECTS.—As during the previous year, the two laboratories engaged in nut-insect investigations were continued. The one at French Creek, W. Va., gave special attention to miscellaneous insects attacking nut crops, and the one at Brownwood, Tex., continued investigations of insects attacking the pecan. Many important facts have been found, leading to practical results of importance.

GRAPE INSECTS.—The investigations of grape insects under way for several years with headquarters at Sandusky, Ohio, in cooperation with the Ohio Agricultural Experiment Station, have been continued along the lines indicated in former reports, particular attention being given to the grape leafhopper, grape-berry moth, and grape rootworm. The grape-berry moth continues to be an important pest throughout northern Ohio and certain localities in Michigan. Control measures developed by the Bureau have been generally adopted by vineyardists, and it has been shown that thorough and timely spraying will reduce injury to an extent that high-grade fruit can be produced even in localities where berry-moth infestation is heavy. Tests of the single-spray method continue to show very satisfactory results and growers have thus been able to cut down spraying costs materially. However, in localities where there are unsprayed or improperly sprayed vineyards and favorable hibernating places for the berry moth, two sprayings are necessary for proper control. In vineyards where the berry moth, grape leafhopper, and grape rootworm coexist, and where berry-moth damage is comparatively light, it has been demonstrated that by advancing slightly the date of application for the second brood of the berry moth, a schedule of applications can be adopted which will treat all three pests by the same spray application. Major attention at present is being given to a careful study of several species of grape leafhoppers which are just now on the increase in the territory under discussion. Tests of magnesium and calcium arsenate have shown that these substances are not as satisfactory as lead arsenate for appliction on grapes on account of danger of injury to foliage and fruit. While calcium arsenate has given satisfaction on Concord grapes, it produced injury on certain other varieties. Tests of casein in various spray mixtures were begun in 1919. Our experience indicates that while the spray has good adhesive qualities, it does not spread over the surface of the berry as readily as when resin-fishoil soap is used. A small amount of soap added to the casein-Bordeaux-lead spray seems to increase the spreading qualities of the spray, however.

Studies of the grape mealybug under way in California have been interrupted on account of the large mortality of the insect due to season and parasitism. The experimental work therefore did not show very decided results. Dormant spraying with a petroleum oil emulsion gives excellent results in destroying the insects and is the present recommendation for this pest. Experiments with paradichlorobenzene in the control of the grape Phylloxera are promising.

Insecticide investigations.—Investigations of miscellaneous insecticides have been continued. Attention has been given to a study of the insecticidal constituents of plants, and in cooperation with the Bureau of Plant Industry a paper has been prepared on plant insecticides. In this investigation 232 preparations from 59 species of plants were tested against a total of 28 species of insects. In all, 260 species of plants have been considered, only about 5 per cent of which, however, can be regarded as containing efficient insecticides.

In the work with contact insecticides in cooperation with the Bureau of Chemistry progress has been made, and manuscript giving results obtained to date has been prepared. Further studies are under way of insecticides from petroleum, many oil fractions and by-products of which have been and are being tested in regard to their availability as contact insecticides. In cooperation with the Chemical Warfare Service of the War Department and with representatives of the Federal Horticultural Board, experiments are in progress with numerous toxic gases to determine their availability for use against insects.

## WORK ON THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

This project has been continued throughout the year under the supervision of A. F. Burgess, with headquarters at Melrose Highlands, Mass.

At the beginning of the fiscal year the work was resumed with an appropriation of $400,000, while $500,000 was really needed to check the continued spread of the gipsy moth in New England and to follow up the exterminative measures that had been inaugurated in the large infested area in New Jersey and in the small colonies in New York State. An appropriation of $600,000 was asked for the fiscal year 1923, with a request that $100,000 be made immediately available. It was expected that this $100,000 would be available by March 1, so that it could be used to finish up the scouting and spraying work in the spring, thus completing the plan of work that had been made for the year. This fund was not available, however, until May 11. Prior to that time it became necessary to reduce the force and to change completely the plan of field operations. In April the entire force would have had to be dropped had it not been possible for a number of the States to come to the rescue at the critical time and finance the work temporarily. In Maine, New Hampshire, and Vermont scouting work was carried on as planned, but the cleaning work in the towns immediately inside the border had to be abandoned on account of lack of funds. In Massachusetts and Connecticut more infestation was found than was anticipated, but shortage of funds at the time when they were most needed made it impossible to scout the area that should have been covered. In addition to this work that had to be neglected, it was not possible to make a thorough examination of a number of towns in eastern New York that should have been inspected, and no cleaning work was done in any of the towns in Massachusetts or Connecticut in accordance with the original plans. All sizable colonies in a strip 25 miles wide along the western border were sprayed, and a considerable area was treated farther east. The results were seriously interfered with by the abnormally heavy rainfall during June.

On July 1, 1922, the Federal Horticultural Board placed under quarantine for the gipsy moth additional areas in New England as follows: Maine, 346 square miles; New Hampshire, 46 square miles; Vermont, 332 square miles; Massachusetts, 1,918 square miles; Connecticut, 1,003 square miles; making a total of 3,645 square miles. Several towns were released from quarantine, as no infestation was found at the time they were examined; there were 3 in Maine, 2 in New Hampshire, and 2 in Vermont.

In New York a colony of the gipsy moth was found at Greenport, Long Island, and a small colony was reported at Patchogue, Long Island. These have been carefully treated and sprayed. The small colonies reported last year in five localities were carefully inspected and treated, and no infestation has been found this year. Most of these colonies resulted from infested trees that had previously been shipped from the Somerville, N. J., area. They must be carefully watched and treatment applied next year, should any infestation be found. It is believed, however, that the insect has been exterminated in these localities. The work in New York has been conducted in close cooperation with the State bureau of plant industry.

In New Jersey all the isolated colonies, nine in number, have been given careful attention and no infestation has been found in any of them. These areas will be rescouted next year and treated if infestations develop. Scouting the woodland north of Somerville was begun in the fall and the whole area was well covered by late spring. Insufficient funds made it impossible to do cutting work on several river-bottom areas that were difficult to treat or spray successfully, but otherwise the program was carried out as planned.

Spraying was conducted on a larger scale than usual in New Jersey, but was much less effective than was expected, on account of almost continuous and heavy rains during May and June. Great difficulty has been encountered in this State in securing competent men who could be trained to carry on the work. The infested section of the State is devoted largely to manufacturing and business enterprises, and few competent men can be found who are interested in active outdoor work. It has been necessary to train large numbers of men drawn from the country districts in New England, and at times it has been extremely difficult to maintain an adequate and efficient force. The work has resulted, however, in a sharp decrease in the number of caterpillars over the previous summer. The area over which the infestation extends is slightly larger than last year, but in no place in New Jersey was there any defoliation by the gipsy moth this summer, and the results for the year on the whole have been encouraging.

New Jersey has expended $125,000 during the year, and close cooperation has existed between the State department of agriculture and the bureau. A quarantine of the infested area has been maintained by the State, and all shipments likely to carry the gipsy moth to points outside have been inspected and certified before being allowed to proceed. The same arrangements have been very effective in the State of New York, where a few small areas are infested. No trace of the insect has been found in the area previously found infested in Pennsylvania.

A limited amount of scouting has been done along the border of the brown-tail moth infestation, and as a result of this work there has been a heavy decrease in the infested area during the year. Two thousand three hundred and forty-two square miles have been released from quarantine in the following States: Maine, 323; New Hampshire, 917; Massachusetts, 64; Rhode Island, 1,038.

The maximum spread of the brown-tail moth was in 1914, when over 38,000 square miles was infested, including portions of all the New England States and eastern end of Long Island, New York. Now this insect is known to be present only in Maine, New Hampshire, and Massachusetts, and the maximum infested area has been reduced 67 per cent.

The area in New England infested by the gipsy moth and the brown-tail moth has continued under quarantine and all shipments likely to carry these insects have been inspected and certified before being removed from the infested area. This has been done to safeguard other sections of the country from long-distance spread of these insects.

One expert assistant has been sent to Japan and one to Europe to study gipsy-moth conditions and to secure and ship parasites and other natural enemies to America. It was also desired to study the fluctuations of the insect and the injury caused by it in its original homes in the hope that this knowledge may be helpful to us. In Japan a survey was made of the region easily reached from Yokohama, and investigations were also made in the vicinity of Sapporo on the island of Yezzo. So few gipsy moth were found in the latter region that it seemed best to confine the greater part of the work to the territory near Yokohama, where several fair-sized infestations were available. Biological studies were taken up at this point and several shipments of parasites have been forwarded to the gipsy moth laboratory in Massachusetts. Owing to failure to have these shipments properly iced throughout the entire trip, they arrived in poor condition.

The European investigations consisted of a survey of conditions of gipsy-moth infestation in France, Italy, Spain, and Germany. The infestation in Germany this year is practically negligible, and the same is true of Austria and Poland, the latter country having been visited in the hope of securing natural enemies of the gipsy moth. Very little parasitic material has been received from Europe this year as a result of this investigation, but data concerning conditions have been secured and considerable work that is of particular value in the parasite investigations has been done in the museum at Berlin and elsewhere.

The parasites and natural enemies of the gipsy moth and brown-tail moth that have already become established in New England have been found in large numbers in some localities. The great difficulty appears to be that all the different species concerned are not abundant enough over a wide area so that a reasonable measure of control results. Colonization work was continued and areas in all the infested States received plantings of parasites that did not occur there heretofore. There still remains a considerable amount of this work to be done before all of these beneficial species are liberated throughout the infested area.

The temperature during the winter was extremely low in many sections of New England. On this account an enormous number of gipsy-moth egg clusters failed to hatch. This has resulted in a decreased amount of defoliation from that of the previous year, particularly in localities where the egg clusters were laid high on the trees and were not protected during the winter by snow or ice. Considerable defoliation by the gipsy moth has been observed in New Hampshire, south of Lake Winnepesaukee, and in the southwestern section of Maine. In parts of this region the trees were denuded over large areas. In many of these localities the wilt disease destroyed many of the larvæ and parasites were abundant. There has been less defoliation in Massachusetts and Rhode Island than during the previous year.

## CEREAL AND FORAGE INSECT INVESTIGATIONS.

W. R. Walton has continued in the leadership of the important work of this section.

European corn borer.—In August, 1921, subsequent to my report of last year, the corn borer was discovered on the islands in Lake Erie immediately opposite Sandusky, Ohio. Scouting operations promptly showed that the insect had become established in small numbers along the entire shore of the lake in New York, Pennsylvania, and Ohio. In Michigan it was also found in a few townships along the lake just south of Detroit.

How the corn borer became established in this important territory is not definitely known, but there is circumstantial evidence that the moths may have been blown by the wind across Lake Erie from the intensely infested area immediately south of London and St. Thomas, in Ontario, Canada. The records of the Weather Bureau show that the prevailing winds blew rather constantly from that region during the flight season of the moths in 1921. In order to study the insect in this new area, a field laboratory has been established at Sandusky, Ohio, for the purpose of learning all the important facts which may in any way be used to combat the pest in this region. Stations as centers of scouting and certification of crops have been established at Cleveland and Toledo, Ohio.

While injury to crops by the corn borer in the newly infested territory in Ohio and Michigan is not likely to become very evident for some time, perhaps not for several years, nevertheless the close proximity of this new infestation to the principal corn belt of the country makes it practically certain that the pest will reach that region by flight or otherwise within the next few years.

The work of introducing the natural enemies of the corn borer from Europe has made rapid strides during the year. Experts located at Hyères, southern France, have been almost constantly collecting and shipping insect parasites of the corn borer to America, where these have been assorted and reared, to be subsequently liberated in large numbers in the heavily infested regions of New England. More than 500,000 specimens of a single species of parasite have been liberated in this manner during the summer of 1922, and thousands of individuals of several other kinds have also been liberated in this region. The present plans of the bureau include the continuation of this work in order to insure, where possible, the establishment of all available beneficial insect enemies of the pest before it becomes widely distributed throughout the United States. With this in view, what promise to be successful steps have been taken to establish one species of these parasites on native corn borers in the South Atlantic and Gulf States, so that this enemy may be present and ready to attack the pest in case the European corn borer should spread to those regions.

Many other lines of investigation are being followed out to find if possible sound means of control. Some of these are modifications of farm practice, such as plowing under or burying infested stubble, weeds, etc., the feeding of infested forage to live stock, the effect of placing it in silo, and its preparation by machinery for ensilage. The use of chemicals as weed killers, to control the insect in weed areas, is being investigated with some success. The variation in the time of planting corn and the selection of varieties and the use of trap crops are being studied, and insecticides are being investigated as well. Every possible line of research which may lead up to means of control is being followed up.

A reduction of $75,000 which was made in the appropriation for the fiscal year ending June 30, 1923, will render difficult the proper carrying on of all the important work which ought to be done, especially in view of the comprehensive scouting and other operations which will be necessary under present conditions. Some of the States involved have agreed to aid in this work, and New York has in fact appropriated $25,000.

The Dominion of Canada is heartily cooperating in this investigation.

The sorghum midge.—Since the publication in 1911 of a preliminary report on investigations of the sorghum midge, it has been apparent that this pest is the limiting factor in the production of the grain sorghums in southern and western Texas and elsewhere. Investigations were begun two years ago, and we have now a simple and effective preventive method, based on agronomic and cultural practices, which promises almost complete relief from this formidable and wasteful pest. This will soon be given out to the growers.

The so-called green bug.—The entomologists of Kansas, Missouri, and Texas have been cooperating with the Federal field-crop insect investigators in conducting a survey in order to determine the status of the green bug in the region most subject to its ravages. The results of this survey have shown conclusively that major outbreaks of this destructive wheat pest are dependent exclusively on the presence of volunteer grain, which permits uninterrupted breeding of the pest throughout the year. In northern Texas, where dry conditions prevailed last fall and no volunteer grain was available, the green bug was almost absent. In northern Oklahoma and south-central Kansas, however, where conditions permitted volunteer grain to flourish, there appeared destructive local outbreaks of the insect, which did considerable injury, especially to oats. It is proposed to make an annual survey like this and to forecast general outbreaks of the green bug for some months in advance. The remedy for the situation, however, obviously is for farmers to abandon the practice of allowing volunteer grain to spring up and become permanent breeding places for this pest.

Grasshoppers.—As stated in last year's report, the last session of the Sixty-sixth Congress ordered an investigation of methods for the control and destruction of grasshoppers, appropriating for this work the sum of $40,000, which became available on July 1 last. During the past year it has been found unnecessary to use more than $20,000 of this money. The results of the activities under this appropriation have been the saving of crops in North Dakota and Wyoming alone in an amount to exceed $600,000. In the former State normal conditions now prevail. In addition to this, much work of a similar character has been done in Oregon, California, Arizona, and other States. An expert has also been stationed in northern Texas who has learned much that will be useful in case of grasshopper increase. At the present writing outbreaks of large proportions are in progress in Montana and Wyoming. The bureau foresaw this and established a field laboratory at Billings, Mont., in April last, and has four experts on the ground busily engaged in aiding farmers and extension workers in combating the pest. The Federal, State, and Canadian entomological forces have formed an informal organization to aid in the work of controlling grasshoppers by adopting uniform plans of procedure.

The Hessian fly.—Thanks to the work of State and Federal entomological workers, the wave of Hessian-fly infestation of 1920–21 has passed over the winter-wheat belt and has waned without inflicting major injury to the crop. The results of recent surveys show the insect to be present in minimum numbers everywhere except in small areas where local conditions or slack farm practice have given it refuge. Progress has been made during the year in the study of the principal parasites of the Hessian fly, and publications reporting this work are in press.

THE ALFALFA WEEVIL.—Further progress has been made toward the economical control of the alfalfa weevil by dusting with arsenicals which will further simplify control and obviate the necessity of hauling water for spraying purposes in the arid regions where this pest occurs. It is hoped to publish this method in the near future. One of the parasites of the alfalfa weevil, imported from Europe before the war, is doing good work, and the weevil is being studied in south France with a view of importing other helpful parasites.

## STORED-PRODUCT INSECT INVESTIGATIONS.

Investigation of this group of insect injuries has continued under Dr. E. A. Back's leadership.

INSECTS ATTACKING GRAIN AND GRAIN PRODUCTS.—The research laboratory at Orlando, Fla., established for the study of the biology of the corn or rice weevil under semitropical conditions, was discontinued during the past year. The Florida investigation yielded new and valuable scientific data that have appeared in printed form. The work has been moved northward to Washington, D. C., where similar studies of all grain pests are being made under different conditions of temperature and moisture.

The laboratory at Thomasville, Ga., has been continued along the same lines as mentioned in my last report. While State and Federal officials still estimate that weevils destroy approximately 10 per cent of the corn crop of the South, the work conducted from Thomasville as a center, and in cooperation with the Georgia Agricultural Experiment Station, has greatly improved conditions in the area concerned.

BEAN AND PEA WEEVILS.—The biological studies of bean and pea weevils and the effect of cold storage and fumigation as remedial measures have received further attention at the Alhambra (Calif.) laboratory, but special emphasis during the past year has centered upon a study of varietal susceptibility and the relation of date of planting and harvesting to the degree of field infestation. Satisfactory progress has been made and reports are already available in printed and manuscript form.

INSECTS ATTACKING MEAT.—Our investigation of insects attacking meat, and particularly of the ham skipper and larder beetles, has been continued as a major project. Meat valued at over $1,000,000 is annually condemned by the inspectors of the department on account of infestation by these insects. Assistance is being given the Bureau of Animal Industry at its Beltsville farm along lines of control which alone make possible the conduct of important experiments in meat curing, etc. Much information new to science is being secured. A paper summarizing important biological facts concerning the ham skipper has already been published.

DRIED-FRUIT INSECTS.—An investigation of insects attacking dried fruits has been started during the past year with headquarters at

Fresno, Calif. At the time of this report the work has hardly passed its preliminary phases.

Experiments with woods of insecticidal value.—The experiments to determine the value of cedar chests, mentioned in my last report, have been brought to a satisfactory conclusion, and results are now available in published form. It has been found that while well-made cedar chests can not be depended upon to kill adult clothes moths and their eggs, nor the half-grown to full-grown larvæ, they can be depended upon to kill the newly hatched and very young larvæ. At the request of manufacturers, other species of cedar, redwood, camphor, and other woods are receiving similar attention.

Household insects.—Insects troublesome in homes, including particularly the bedbug, clothes moths, carpet beetles, and silverfish, have continued to receive attention. During the past year special attention has centered upon the biology of clothes moths as affecting the brush and fabric industries. Valuable information has been obtained. The work has not received the attention it deserves, through lack of funds. A special bulletin dealing with fabric pests has been prepared and submitted for publication.

Cold storage for the prevention of loss by insects.—An investigation into the effect of cold-storage temperatures upon the life of insects in commodities has been started and already is yielding beneficial results. This is a relatively new field of investigation. Experiments already completed indicate the value of cold storage for the destruction of bean and pea weevils in beans. All stored-product pests are being made the subject of investigation in connection with cold temperatures. A progress report has already been read before the American Association of Ice and Refrigeration, which has offered the hearty cooperation of its members.

Fumigation work.—The investigation of the value of fumigation in the prevention of losses through insect attack in warehouses continues to be an important phase of the work of the bureau. Industries throughout the country are calling upon the department continually for information regarding the protection by fumigation of stocks of raw wool, grain, grain products, beans, cowpeas, candies, meats, hides, brushes, fabrics, furniture, and a long array of other susceptible raw and manufactured products.

Inspection and intelligence service.—The cooperation with the Army and Navy has been continued in the way indicated in my last year's report. This service during the past year has been directed more largely toward furnishing the Army and Navy with information regarding the susceptibility of various fabrics to moth attack. This work has been conducted at Washington, the laboratory maintained during and since the war at the Army Supply Base at Brooklyn, N. Y., having been discontinued during the past year.

## TROPICAL AND SUBTROPICAL FRUIT INSECTS.

This work has been carried out under the direction of Dr. A. L. Quaintance, in cooperation, in certain cases, with the Federal Horticultural Board.

Insects affecting citrus fruits in California.—The experiments under way for the control of the citrus red spider at the Alhambra station continued through the growing season of 1921 and confirmed earlier conclusions of the superiority of a distillate cresylic acid soap emulsion spray. Further progress was made in the investigation of liquid hydrocyanic-acid gas.

In the southern San Joaquin Valley, in cooperation with the entomologist of the California Fruit Growers' Exchange, experiments were made to determine the comparative merits of dusting and spraying for the citrus thrips. The dusting method was found to be decidedly inferior to spraying.

CITRUS-FRUIT INSECTS IN FLORIDA.—At the Orlando, Fla., station work on the rust mite has been continued throughout the year. This project has proven to be a most intricate one, as it has been very difficult to determine the host plants of the mite or satisfactorily to study its life history. Methods for rearing the rust mite, however, have now been developed and new facts relating to its life history discovered which bear directly on methods of control. Several forms of sulphur have again been tested against the mite, and the merits of sulphur dusts in comparison with liquid sulphur sprays determined. Continued progress has been made in the use of Bordeaux-oil emulsion spray for the simultaneous control of citrus diseases and insects, as mentioned in the last report, the work being carried out in cooperation with the Bureau of Plant Industry of this department. Experiments are in progress to develop an adhesive for sulphur, so that if possible it will remain on citrus foliage a much longer period than at present.

INVESTIGATIONS OF INSECT-KILLING FUNGI.—Studies of insect-killing fungi in Florida, especially in relation to their value in the control of citrus insects, were made. Further information has been obtained concerning the fungus diseases of the citrus mealybug. This knowledge will be of distinct advantage to growers, and it is hoped will save them material expense by eliminating the very unsatisfactory remedial measures employed in the past. While the fungus has not as yet been cultivated on artificial media, it can be disseminated by means of distributing infested insects. The mealybug can be reared in quantity on potato sprouts, infected with the disease, and readily distributed to citrus growers. As stated in the last report, fungus parasites of the rust mite have been discovered and further knowledge concerning them secured. It is believed that one of these fungi can be grown artificially and thus be utilized at times when it will do most good. The fungus will supplement the use of sulphur sprays, especially in early spring, when for any reason these treatments can not be given. Further experiments in the use of fungus parasites of the white fly and purple scale have shown that by spraying with a spore solution, largely during the crawling stages, a mortality of about 85 per cent can be obtained if the host plant is in some way protected from rains after treatment. The discovery of the desirable stage of the insects at which to make the application of the spore mixture points out the need of a medium which will serve to stick the spores to the leaves and insects in spite of rains.

INSECTS AFFECTING MANGO, GUAVA, AND OTHER SUBTROPICAL FRUITS.—Investigations of these insects have been continued, with headquarters at Miami, Fla. Biological studies of the avocado white fly, *Trialeurodes floridensis*, have been completed. Various parasites have been found which attack the species, some of which have been studied. An efficient spray schedule with insecticides has been determined for the control of this pest. Much additional information concerning the life history of the pyriform scale, *Protopulvinaria pyriformis*, a pest of avocado trees, has been obtained and a report on this work will be prepared in due time. Particular attention has been given to experiments in the control of the papaya fruit fly, *Toxotrypana curvicauda.* Several acre plats of papayas have been under observation where various methods of treatment were in progress. The tests have included the use of poisoned baits, barriers, bagging, various oils, etc. Several bulletins reporting on the work of this project have been issued during the year, as the "Avocado red spider": "The avocado, its insect enemies and how to combat them"; "Insects injurious to the mango," etc. Experiments are under way at Homestead, Fla., in developing control for the avocado mealybug, also known as the coconut mealybug (*Pseudococcus nipae*). This is a serious pest of the avocado in certain regions.

INVESTIGATIONS OF THE MEDITERRANEAN FRUIT FLY AND THE MELON FLY.—The work during the past fiscal year at the bureau's laboratory at Honolulu, Hawaii, may be divided into three general parts, namely, plant quarantine enforcement, Mediterranean fruit-fly parasite investigations, and methods of control of bruchids attacking the algaroba bean.

The enforcement of plant-quarantine regulations is done in cooperation with the Federal Horticultural Board, and consists mainly of inspection of fruits and vegetables for shipment to the mainland and supervision over plantations and packing sheds. Details of this work will be found in the report of the chairman of the Federal Horticultural Board.

The fruit-fly parasitism investigation has consisted chiefly in obtaining daily records of parasitism by each of four species of introduced parasites. These records have been summarized and will show the amount of control exerted by these parasites and the degree of infestation of various fruits by the fly.

Four species of bruchid parasites have been reared and liberated. They were brought from Texas to Hawaii in July, 1921, with the result that one of them (*Lariophagus texanus*) has been well established in the field, having been recovered from many localities. Much information has been secured on the degree of control exerted over Bruchidae in algaroba beans by an egg parasite, *Uscana semifumipennis*, and a larval parasite, *Heterospilus prosopidis*, which have been in Hawaii for some years.

INVESTIGATIONS OF FRUIT FLIES AND OTHER TROPICAL AND SUBTROPICIAL FRUIT INSECTS IN THE CANAL ZONE.—Work has been continued at this field station. Close survey is maintained of injurious insects of the region, especially to detect those recently established. Particular attention was given during the year to the avocado weevil, *Heilipus perseae*, and the avocado-seed insect, *Stenoma catenifer*. The citrus black fly, *Aleurocanthus woglumi*, has received major attention among the citrus insects, and data are available for a second report on this important pest, dealing with biology and control. The insect is continuing to spread and constitutes a dangerous source of introduction into the citrus States. The insect enemies of the mango and papaya and the coconut palm have been studied. Attention has constantly been directed to locating as many fruit flies as possible, but thus far only four species have been obtained. No fruit flies have been bred from avocadoes, nor has any suspicious fruit been seen.

Studies of greenhouse insects.—The strawberry rootworm, which is a serious pest of roses under glass, has continued to receive a large amount of attention, the work being done in cooperation with the Pennsylvania State Department of Agriculture, with headquarters at Doylestown, Pa. The life history of the pest has been fairly well worked out and experiments in control have progressed to a point to warrant the issuance of recommendations. Fumigation with hydrocyanic-acid gas at the rate of 1½ to 2 ounces per 1,000 cubic feet of space is not only suitable for a single unit type of house, but by using heavy muslin curtains the gas may be confined to any section of an open-range house. A number of open-range houses, involving 33,000 rose plants, have been fumigated consecutively at the above rate with a mortality of beetles of about 97 per cent, and no injury whatever to the plants was to be noted from the treatment. It has also been ascertained that the rose beetle can be reduced to a negligible quantity by keeping beds free from mulch, manure, and dead leaves during the winter months if persistent hand picking of the beetles is resorted to during the latter part of the summer. Further studies of the bulb mite, *Rhizoglyphus hyacinthi*, have been made, including tests of numerous insecticidal materials. Paradichlorobenzene proved to be most effective in killing the mites. During the fiscal year studies of the greenhouse leaf-tyer have been concluded and a control program worked out, involving a combination of remedies directed progressively against the several stages, beginning with the adult.

In cooperation with the superintendent of the United States Botanic Garden, important experiments have been carried out to determine the practicability of frequent fumigation of greenhouses with hydrocyanic-acid gas in order to keep the greenhouses free from such common insects as white flies, etc. No permanent injury followed, and the houses were kept virtually free of pests by the treatment given. The results are of much importance to florists as indicating the desirability of adopting the practice of frequent fumigation with reduced strengths of gas as a means of keeping under subjection their injurious insect pests.

The camphor scale.—Progress has been made in the investigation and control of the camphor scale, *Pseudaonidia duplex*, in cooperation with the Louisiana State Department of Agriculture and the administrative authorities of the city of New Orleans. The distribution of the insect was ascertained to be more general than anticipated at first, demonstrating the impracticability of an eradication program. Special attention was given during the year, with funds supplied largely by the State of Louisiana and the city of New Orleans, to large-scale spraying operations to protect valuable shade trees along the streets and in the parks. This work served as an object lesson to many citizens in New Orleans, and, along with other educational effort in progress, it is believed will serve to induce property owners to undertake spraying operations to protect the trees on their own account. The camphor scale has also been found at Hattiesburg, Miss., and quite recently at Grand Bay, Ala. These outbreaks have been investigated and proper State authorities advised of the occurrence of the insect within their States. Beginning the latter part of the fiscal year, when Federal funds became available, a laboratory for a careful study of the camphor scale was established in New Orleans.

## VEGETABLE AND TRUCK-CROP INSECT INVESTIGATIONS.

Work on this project has continued under the direction of Dr. F. H. Chittenden. The great economic importance of the Mexican bean beetle, its sudden appearance, and rapid dissemination in the Southern States have caused a large portion of the work on this general project to be devoted to it as a subproject.

THE MEXICAN BEAN BEETLE.—At the beginning of the fiscal year (July 1, 1921), the Mexican bean beetle was known to be present in 83 counties of the 5 States of Alabama, Georgia, Tennessee, South Carolina, and Kentucky. Continued scouting during late summer disclosed its presence in 111 counties in 6 States, North Carolina being added to the infested list. Everything points to the fact that the beetle is even more at home in its new environment and is more prolific and more destructive than in the West and Southwest. No scouting to follow the insect's spread during the early summer of 1922 has been possible, but reports of injury indicate that the beetle passed the winter successfully over most of the territory infested last year. The largest number of complaints came from the northern part of the previously infested area, indidating that a rapid spread to the north may be expected. Growers are now complaining of injury by the bean beetle in districts in which the insect could be found only by careful inspection last season. Extensive field experiments with most available insecticides have been continued in cooperation with the Alabama Agricultural Experiment Station. It appears that the application of arsenicals to bean plants in the southeastern United States is more hazardous than in the West and Southwest. A commercial basic lead arsenate, used as a dust or as a wet spray, at the rate of 1¼ pounds to 50 gallons of water, ranks first among arsenical applications. Standard lead arsenate is too injurious to bean foliage. Calcium arsenate and zinc arsenite are injurious when used as dusts undiluted. Calcium arsenate, however, can be used effectively and with relative safety as a dust when diluted with 9 parts of hydrated lime. The insect is being carefully studied in the field. In 1921 a maximum of four generations was obtained and in this section the insect requires at least two generations to maintain itself, while in the West and Southwest one full generation and a partial, or smaller, second generation are the rule. Experiments have been successfully performed to determine the flight of the beetle. Marked beetles have been taken 5 miles from the point of liberation within a few days. The beetle migrates to woodlands and spends the winter under pine straw and leaves in protected places, a high percentage of survival having been noted. Of new host plants, cowpeas, beggar weed, alfalfa, and sweet clover are notable, beggar weed seeming actually to be preferred to other hosts than the garden bean. A substation has been established at Thomasville, Ga., in cooperation with the Georgia State Board of Entomology, for the study of the insect under extreme southern conditions. A hibernation cage containing 18,000 beetles was placed on Lookout Mountain, Tenn., and interesting comparisons have been gained between these rather severe conditions, which correspond to a sea-level latitude much farther north, and conditions at Thomasville, Ga., near the Florida line. It seems probable from these studies that the Mexican bean beetle will be able to extend its range over a very large part of the continental United States. Careful studies have been made of the possibilities of natural control. A number of new predacious enemies have been observed, but none has been effective. An expert is engaged in searching for parasites of the insect in Old Mexico.

OTHER INSECTS INJURIOUS TO BEANS AND PEAS.—Work on the control of the pea aphis was continued in California, with especial attention to cannery peas. Nicotine dust was found impracticable because of unfavorable weather conditions, but spraying proved satisfactory, the formula of three-fourths pint of nicotine sulphate and 8 to 10 pounds of soap to 100 gallons of water being more effective than the formula previously used, i. e., 1 pint nicotine sulphate and 4 pounds soap. With the use of a large, power-driven outfit covering 6 rows at a time, 12 acres a day were covered, and probably 18 acres a day can be reached with some improvements. The total cost of spraying, using 100 gallons to the acre, was about $2 per acre for material and labor. Life-history studies of the beet army worm (*Laphygma exigua*) on peas show a possible maximum of 5 generations a year in southern California, although ordinarily only 4 occur. Although the young worms feed inside the terminal clusters under a weblike covering, making it difficult to reach them with a spray, a satisfactory method of control was obtained by spraying with lead arsenate, 3 pounds to 100 gallons of water. Work on the bean fly or seed-corn maggot has been the subject of research in New Jersey for several years past and has just been completed, embracing a thorough study of the biology and life history and a knowledge of its breeding habits during the summer months. The bean leaf-beetle and bean aphis are also being studied in different regions.

SWEET-POTATO WEEVIL ERADICATION AND CONTROL.—The sweet-potato weevil eradication campaign in Alabama, Mississippi, Georgia, and Florida is continuing as heretofore, and the expected progress in Baker County, Fla., and Charlton County, Ga., is being made, the number of infested farms and the infestations having been lowered to such a degree that the large commercial areas surrounding are now no longer threatened. All sweet potatoes on the infested properties are carefully checked and disposed of under the supervision of inspectors. Although no weevils have been found in Charlton County during the past year, measures are being continued on all suspicious properties, and the systematic inspection prevalent over the entire area is being facilitated by better cooperation with the growers than ever before. New projects in Polk and Hillsboro Counties, Fla., based on different plans of eradication, are being followed. It is as yet too early to give any definite information on results. With the elimination of the weevils from the three districts above mentioned, the State quarantine forces should be able to protect the sweet-potato industries of their respective States. In Alabama no weevils have been found in the area formerly known to have been infested. In Mississippi very satisfactory progress is being made in Pearl River, Hancock, and Harrison Counties. New infestations, however, have developed in Jackson and George Counties. The hearty and thorough cooperation of the plant boards of Alabama, Mississippi, Georgia, and Florida has materially facilitated the progress of the eradication campaign.

INSECTS DESTRUCTIVE TO CABBAGE AND RELATED CROPS.—Lead arsenate and Paris green sprays and laundry soap added as a spreader or "sticker" for the control of the common cabbage worm have proved effective. Preliminary experiments were made with nicotine dust for the flea-beetles which are specific enemies of cruciferous plants in Louisiana, with encouraging results. Nicotine dust was also applied effectively in the District of Columbia and vicinity and in New Jersey for cabbage flea-beetles, with the result that it killed all with which it came in contact, but, since these insects are extremely active and hop and fly readily, it is difficult to give a definite statement as to results. The various plant-lice or aphids which attack cole crops, including the cabbage aphis, turnip aphis, and spinach aphis, have been found to yield to dusting by nicotine, which kills a very high percentage.

INSECTS INJURIOUS TO POTATO AND RELATED CROPS.—Experiments on the potato leafhopper, the cause of potato "hopperburn," have been continued under abnormal weather conditions, and a clear-cut influence of the treatment upon foliage conditions and yield was less evident than in former years. Three types of experiments, covering effective planting dates, effective number of sprayings, and resistant seed selection, were carried on, and commercial experiments on a large scale in several northern counties of Wisconsin are now under way, with a view to ascertaining the variations in treatment necessary on different soil types and under various climatic conditions. Farmers' Bulletin No. 1225, entitled "The potato leafhopper and its control," has been issued and covers the subject in a practical way to date. Work on the potato aphis is nearing completion, and additional facts have been learned in regard to the life history and control of the spinach aphis, the tarnished plant-bug, and flea-beetles on potatoes and related crops.

THE STRIPED CUCUMBER BEETLE.—The control of the striped cucumber beetle from a practical standpoint has been brought near completion through the excellent results obtained by nicotine dusts. A preliminary report has been published showing how this, our most destructive pest of seedling cucumbers, can be controlled by the use of a dust containing 1.6 per cent nicotine. In Wisconsin a combination of nicotine-Bordeaux dust, prepared by spraying nicotine sulphate on powdered monohydrated copper sulphate and lime, secured even better killing than did the nicotine-kaolin and lime mixture, apparently evolving nicotine more slowly and hence acting over a longer period than the usual mixture. The method of application is of the greatest importance to obtain the best results. A good volume of dust thrown quickly and with force to drive the beetles from cracks in the soil about the plants and to reach active individuals which escape by flight has been found necessary.

STRAWBERRY AND BLACKBERRY INSECTS.—Work on the strawberry leaf-roller in New Jersey has been completed during the fiscal year. It embraces a thorough study of the insect's biology in its occurrence in that State and methods for its control. Certain parasites reared and studied have proved of considerable economic importance. The addition of a spreader, such as lime, gelatin, or fish-oil soap, was determined to be essential in control by arsenicals, since on strawberry foliage the under surface, which must be reached in order to poison the insect, is strongly pubescent and ordinary sprays applied without a spreader tend to collect in drops instead of giving an even coating. Spraying should be applied as soon as the eggs hatch, because later the larvæ construct protective tents or roll the leaves. Burning and cleaning the fields as soon as the crop is removed is also a measure of importance. A report covering this work is available as a bulletin. Observations and control experiments on the strawberry weevil were continued in the Chadbourn (N. C.) district. The strawberry leaf-beetle (*Haltica litigata*) was the cause of considerable concern in Louisiana, where nicotine dust proved effective. Life-history work on this species has been begun.

Sugar-beet insects.—Work on the curly-top leafhopper in cooperation with the Bureau of Plant Industry has continued. The exact limits of overlapping generations have been the subject of cage experiments, and one year's breeding work has been completed. Particular attention has been given to the native flora which might serve as reservoirs for curly-top virus and the relation of filaree and *Chenopodium murale* is also being investigated. The production of resistant seed at Riverside, Calif., through the medium of inoculated stecklings is developing some promising features. Although the plants are inoculated from one to three times, a large percentage of the best selections show normal growth.

Nicotine dust as a means of insect control.—In previous paragraphs mention has been made of the value of this insecticide and deterrent for specific insect pests affecting vegetable and truck crops. It is hoped that a dust will be developed from which all of the nicotine will be available, since, as at present manufactured, a certain proportion of the nicotine is unavailable, with consequent waste of expensive material.

General truck-crop insects.—The Porto Rico mole cricket, recently introduced into South Carolina, has been the subject of experiment with poisoned baits with excellent success. The results of several years' work on blister beetles, important enemies of vegetables and truck crops in the West, have been completed and published.

## SOUTHERN FIELD-CROP INSECT INVESTIGATIONS.

Investigations of insects affecting southern field crops have been continued under the direction of Dr. W. D. Hunter.

Cotton insects.—As in preceding years, the work has been centered around the further development of the process of controlling the boll weevil by dry calcium-arsenate dust. Studies in the application of this poison were continued at the various field substations under the direction of the Delta Laboratory. Plat tests were carried through to completion in Mississippi, Alabama, Texas, Georgia, and South Carolina. Much valuable information was obtained in this way as to the modifications of the poisoning system necessary to successful weevil control under varying conditions and in widely separated cotton-growing regions. It was found that in most cases the system can be adapted in a way to make poisoning profitable under these different conditions on land which normally produces one-half bale or more per acre. Much valuable information was secured also on the exact limitations of profit in boll weevil poisoning.

The development of dusting machinery has been continued. There are now over 40 different machines on the market, practically all of which were previously tested at the Delta Laboratory. Progress is being made on the development of new types of machines suited to conditions for which no machines are at present available. This has resulted in the recent appearance on the market of the so-called saddle gun or mule-back gun. While this machine is still in the developmental stage, apparently it has much promise of usefulness.

The studies on the quality of the various types of calcium arsenate on the market have been considerably elaborated and a cooperative project inaugurated with the Bureau of Chemistry. Methods of manufacture are being studied in order to determine the causes of variations in the completed product in relation to its adhesiveness, ease of distribution over the plant, etc. The investigation undoubtedly is leading to a considerable change in methods of manufacture and a much improved product.

The chemical inspection is being continued as in the past in cooperation with the Federal Insecticide and Fungicide Board. This includes both the examination of unofficial samples of calcium arsenate submitted by county agents and the study of official samples taken by inspectors employed by the Insecticide and Fungicide Board. In connection with the latter type of inspection, evidence for court cases is secured whenever the material is found to be unfit for use.

Studies on the deterioration of stored calcium arsenate extending over a period of several years have just been completed and a manuscript on the subject has been prepared for publication. The investigation has led to important modifications in the kind of containers recommended for the shipment of calcium arsenate, and has done much to standardize the supply. These studies also were made in cooperation with the Insecticide and Fungicide Board.

An interesting development of boll-weevil poisoning is the fact that in some localities the use of calcium arsenate so reduces the natural enemies of the cotton aphis that the latter becomes seriously injurious to cotton. Investigations are being conducted to determine the best method of control of the cotton aphis in connection with control of the boll weevil. Studies are also being conducted bearing on the relation between the use of calcium arsenate and the possible incidental control of the bollworm.

TOBACCO INSECTS.—The most important addition to tobacco hornworm control has been the perfecting of a tandem-wheel shaftless type of one-mule two-row duster for the application of insecticides to the tobacco plant. The work was begun two years ago and was mentioned in the annual report of last year. Since that time more than 200 acres have been dusted with the experimental model with much better results than could have been obtained with hand dusters. As much as 18 acres has been dusted in a single day, about three times as much as could have been done with a hand duster. A patent to be dedicated to the public has been applied for, and already one of the older manufacturers of dusters has begun the construction of experimental models of this type of machine. The advantages of the shaftless type over the shaft type of two-row duster lie in the fact of the lower center of gravity and the fact that it can be turned in half the space required by the shaft type. It is also thought that the cost of construction will be less than that of the shaft duster.

The most severe outbreak of crambids ("screw worms") on record for this region occurred this year. Many tobacco fields had to be almost completely reset twice. A large number of other fields were so badly infested that two and even three heavy replantings were necessary. Two species were about equally concerned in the injury, *Crambus caliginosellus* and *Acrolophus popeanellus*. A poisoned bait containing an attractant, the first direct remedy on record, was found to give a control of 88 to 89 per cent on *caliginosellus* in some experiments and a control of 86 to 93 per cent in other experiments. However, further experimentation is necessary before exact methods of application should be advised.

The work upon the life history of the tobacco flea-beetle at Quincy, Fla., mentioned in the last report, has shown very satisfactory progress. In addition to three generations in direct line, the number of larval instars has also been determined and control work has been continued and improved upon. The tobacco thrips were scarce again, and nothing more than preliminary experiments with nicotine dusts could be performed.

A preliminary survey of the tobacco-insect problems of the Burley tobacco belt has been made, and a great lack of adequate and economical methods of control found. Arrangements have been made for a few large-scale field experiments upon hornworm control in this region.

Sugar-cane and rice insects.—The tachinid parasite, introduced from Cuba and released upon various plantations for the purpose of controlling the sugar-cane borer, was found in the fall of 1921 on 18 plantations scattered throughout the sugar parishes of Louisiana. Upon 17 of these plantations it had endured one winter, and in one place it had lived over two winters. It is expected that the parasite will increase at these centers and gradually spread over the entire sugar section.

In addition to the Cuban parasite, specimens of a braconid parasite brought to this country from southern France to control the European corn borer were sent to the sugar-cane insect laboratory at New Orleans. It was not known whether they would attack the sugar-cane moth borer, but they were found to do so readily and to breed on it successfully. These parasites are at present being released at only one plantation, but it is planned to release them generally if favorable results are obtained upon this plantation.

Control work on the moth borer is not confined to parasite introduction, but experiments are being conducted with various chemicals to test their efficiency in killing the larvæ in the seed cane after planting. This work includes tests with paradichlorobenzene, which has given good results in control of the peach-tree borer. A number of chemicals not previously used as insecticides are being tested.

A new lepidopterous larva, boring in sugar cane, has been found along the Mississippi coast, inspections having been made by an agent of this bureau cooperating with the Mississippi plant board.

It was found during the year that the sugar-cane moth borer also damages rice in Louisiana. It probably has been confused heretofore with the rice stalk-borer, which resembles it closely. An investigation of these two pests in their relation to the rice crop has been started.

## INSECTS AFFECTING THE HEALTH OF MAN AND DOMESTIC ANIMALS.

Screw-worm and blowflies.—The investigations on this project have been continued in cooperation with the Bureau of Chemistry and the Texas Agricultural Experiment Station. Extensive experiments have been carried out at several points in Texas to find if possible some satisfactory repellent which may be used to keep screw-worms and blowflies off wounds on animals until they have healed. This has required the testing of a great many substances and many repetitions of the tests. Several very promising chemicals have been found which are to be given extensive tests under range conditions. Attention has been given to finding a less expensive and more stable material than chloroform for killing screw-worms and wool maggots.

It has been conclusively demonstrated that the use of the flytrap designed by the bureau, in conjunction with carcass destruction, is a very effective method of reducing screw-worm and wool-maggot troubles in the Southwest. Experiments have been continued to find effective dry baits which can be carried on horseback in concentrated form for use in flytraps on the range. Dried egg is giving excellent satisfaction and is more generally available and more pleasant to handle than dried intestinal mucus, which was introduced by the bureau three years ago.

Warble or grub.—Studies of the warble or grub of cattle have been continued along lines similar to those reported upon last year. Considerable attention has been given to further studies of the life history and seasonal history of the northern warble, *Hypoderma bovis*, in New York. Further steps have been taken to prepare the people of that section for extensive control work. While the full extent of damage from this pest is not generally recognized by the stockmen and dairymen, they all admit that control or eradicative procedure is well warranted. It is believed that such procedure is feasible, as the insect restricts its attack to cattle. It is present in its later larval stages under the hide along the backs of cattle during a few months only of each year, and in this situation it can be destroyed with certain treatments, such as the application to the openings of iodoform 1 part to petrolatum 5 parts. The principal features in the life and seasonal history of the two species of warbles have been determined with sufficient exactness to make it possible to proceed with tests of control methods on a considerable scale.

Lice affecting live stock.—Studies of the life histories of the lice, especially goat lice, have been in progress during the winter months, and experiments in cooperation with the Texas Agricultural Experiment Station are under way to determine the best procedure to follow in order to insure complete destruction of all lice by dipping.

Insecticide studies.—Further tests with the little-known insecticide derris have been carried out and the results published. This material has been found to be very effective for use in the dust form against lice of cattle and other domestic animals, as well as against fleas. The finding of an effective dry treatment for lice is a matter of much importance to the dairymen and stockmen of the North, where the use of sprays or dips is hazardous during the winter, when the lice usually become most troublesome. Thousands of dollars are spent each year for lice powders, and many of these are entirely ineffective.

Insects affecting the health of man.—The investigation of malaria mosquitoes at Mound, La., has been continued during the year and combines a general biological study of the local species with observations on the effect of certain control measures instituted by the International Health Board.

The field covered by the biological investigation includes: (1) Larval studies—principal breeding areas, conditions favoring maximum production, normal emergence from unit areas, distance from source to food supply; (2) adult studies—normal abundance around dwelling houses, monthly and seasonal variations in abundance, distance of flight, and dispersion of adults; (3) natural control—studies of insect, plant, and fish enemies; and (4) dissection of adult Anopheles to determine percentage of infected mosquitoes in nature and their distribution.

The study of experimental control measures carried out in cooperation with the International Health Board includes: (1) An experiment to determine the effect of collections of adult mosquitoes inside houses; (2) effect of screening the ordinary tenant house upon malaria incidence and Anopheles abundance; (3) effect of clearing and impounding a 3-mile section of a natural bayou; and (4) effect of moving tenant houses to more favorable locations, an investigation which includes a general study of the influence of location on malaria incidence and Anopheles prevalence.

During the year a series of enlarged photomicrographs of different stages of malaria infection in the mosquito host was exhibited at the Hot Springs (Ark.) meeting of the Southern Medical Society. A preliminary paper on normal abundance of Anopheles around tenant houses was read before the New Jersey Mosquito Association and published in the proceedings of their society.

## INSECTS AFFECTING FOREST RESOURCES AND SHADE TREES.

This work has been continued under the direction of Dr. A. D. Hopkins.

Insects affecting forest trees.—The work at the field stations in California and Oregon, and in the northern and southern Rocky Mountain States has been almost entirely in response to requests by the Forest Service, National Park Service, and private owners for examination and report on infested timber and cooperation in conducting control projects.

The southern Oregon–northern California control project.—One of the most extensive control operations against a tree-killing insect ever undertaken is that of the southern Oregon–northern California cooperative control project. Continued and increasing depredations by the western pine beetle on the yellow-pine timber on more than 1,300,000 acres of National Forest, Indian reservation, and privately owned lands in Klamath County, Oreg., and Modoc County, Calif., led to a combined request for a survey and report by this bureau. Following the report Congress appropriated $150,000 to be expended by the Departments of Agriculture and Interior, in cooperation with private owners and the State of Oregon, in conducting control operations on this area under the supervision of representatives of this bureau through a board of control. A cooperative organization was effected under an agreement between the two departments—Agriculture and Interior—and the private owners represented by the Klamath Forest Protective Association. Control crews and camps were organized and work was started in May and completed June 15, 1922. Seven thousand and seventy-nine infested trees, representing 6,672,490 board feet, on an area of 68,620 acres, were felled and barked, and the bark burned, at a total cost of $30,433.63. Approximately $4,000 has been expended on this project from the bureau allotment and a considerable amount was expended in making preliminary surveys from the regular appropriation for forest insect investigations.

THE ANTELOPE CONTROL PROJECT.—The Antelope project is located in northern California on privately owned lands; the cost of the work was paid by the owners, and the supervision was by a representative of the bureau at the Ashland, Oreg., station. On this area 3,200 trees were treated in 1921 and 1,765, on about 10,500 acres, were treated in 1922.

THE SAN JOAQUIN RESEARCH AND CONTROL PROJECT.—The San Joaquin project in California includes both research and control work in cooperation with the Forest Service. The principal control work was completed in 1919, but experiments and studies, with reference to methods of maintaining control, have been continued from our field station at North Fork, Calif.

FIGUEROA CONTROL PROJECT.—This project is in the Santa Barbara National Forest, Calif., and was conducted in cooperation with the Forest Service. Sixty-four trees infested by the western pine beetle on 2,400 acres were treated, at a cost of $200 to the Forest Service and about the same to this bureau.

ARROWHEAD LAKE CONTROL PROJECT.—This project is located in the San Bernardino Mountains of California, embracing an area of about 5,000 acres of privately owned and about 3,000 acres of National Forest land. The work was conducted by the private owners under the supervision of representatives of this bureau. Twenty yellow pine and 44 Coulter pine trees infested with the western pine beetle were treated, representing a volume of 77,030 board feet, at a cost to the private owners of $304.

GRAND CANYON–KAIBAB CONTROL PROJECT.—This is a cooperative project between the Forest Service, Park Service, and Bureau of Entomology, on an area 8 by 28 miles, in the Grand Canyon National Park and Kaibab National Forest, Ariz. Five thousand six hundred and eighty-three pine trees, representing over 1,000,000 board feet, infested by the Black Hills beetle were treated, at an approximate cost of $7,150 to the Forest Service, $1,180 to the Park Service, and $2,700 to the Bureau of Entomology.

SURVEYS AND REPORTS.—In addition to the responses to requests for surveys and reports on Government and privately owned timber included in the above-mentioned control projects, the following made during the year may be mentioned:

Six national-park areas in Idaho and two in Montana were examined and reported upon for the Forest Service, one for Forest Service and private owners, one for private owners in Idaho, and one for the Klamath Indian Reservation in Oregon. These surveys showed that in Idaho and Montana the infestation and timber killed by the western pine beetle and the mountain pine beetle continues about the same as the average in past years, causing in the aggregate a great loss of the best white pine, yellow pine, and lodgepole pine, and that in several places epidemic infestations prevail, especially in the lodgepole pine.

A wind-blown area north of Fort Klamath, Oreg., was examined for private owners. It was estimated that a loss of some 6,000,000 feet had been caused by the wind in November, 1921, but that so far it has not resulted in an expected epidemic of the western pine beetle.

Forest product insects.—Investigations and experiments relating to methods of preventing losses from wood-borer damage to crude, rough, seasoned, finished, and utilized forest products have received special attention through cooperation with manufacturers in Georgia and Virginia. This has consisted of experiments and practical demonstrations with the application of chemicals to sawlogs, submergence in water, treatment of seasoned wood, and methods in general management to prevent losses.

Shade trees and ornamental shrubs.—The work on the insects of this character has been mainly done in Washington, D. C., and in California. The correspondence has been very large, and the bureau has been of much assistance to many towns and cities. Considerable work was done in California from the field stations at Palo Alto, Los Gatos, and Chico, on the Pacific flat-headed borer, defoliating caterpillars, live-oak leaf-gall, mealybug on citrus shade trees, the cypress bark scale, grasshopper defoliation of roadside trees, etc. Work was also continued on the cable beetle, which causes such serious damage to lead telephone cables in California.

Field research.—The greatly increased demand for cooperation with Federal officials and private owners in the Pacific and Rocky Mountain States has been such as to interfere seriously with work on research problems, the solving of which is of special importance as a basis for up-to-date advice and assistance relating to economy and success in the control and prevention of epidemics by tree-killing and wood-destroying insects. Considerable progress, however, on some of these problems was made in connection with the cooperative-control projects.

Research work at Washington.—The research work carried on by experts on forest insects and related problems, which is so essential to successful field work, has been continued, but with a reduced force. In addition to the identification of species, this work has related particularly to the study of beneficial insects and the immature stages of both beneficial and injurious species, in order that they may be identified from any stage or even from fragments of the insects or specimens of their work, all of which is contributing to a marked advance of the science of forest entomology.

Work on the relation of climate to insects and other life under the new science of bioclimatics has been continued, both at Washington and at a temporary field station in West Virginia.

PRINCIPAL RESULTS.—The most important result of the year is one for which we have been striving for many years, namely, increased interest and confidence in the work of the branch of forest entomology and its recommendations. This is now manifested in a most gratifying way by National Forest, National Park, and Indian reservation officials, and especially by representatives of some of the principal private owners of timber and manufacturers of forest products. There is a marked increase in requests for information and advice and for our cooperation in dealing with some of the big problems involving the loss of standing timber and forest products. It is becoming recognized, especially in the West, that forest entomology is an essential phase of forest conservation. The increased interest and confidence are also shown in the fact that within the closing months of the fiscal year, over 1,400,000 infested trees, representing more than 8,000,000 board feet of timber, were treated according to the recommendations and under the supervision of representatives of this bureau, at a cost of over $46,000.

Inspection of areas on which control work was done during recent years showed most gratifying results in the ending of the epidemics and consequent saving of a great quantity of timber. Among other results that may be mentioned are:

(1) Verification of the principle of continuous logging operations as a means of preventing epidemics of tree-killing insects.

(2) Evidence that the epidemics of tree-killing insects do not come in regular but in irregular cycles.

(3) Demonstrations of the importance and economy of cooperative insect-control work.

(4) Evidence that hardwood submerged in water, as sawlogs or as lumber, is immune against powder-post attack after the wood is seasoned.

(5) The discovery in practical tests that liquid orthodichlorobenzene is effective in killing borers after they have entered the wood, and that paradichlorobenzene dissolved in kerosene gives similar results.

(6) Practical tests of the solar-heat method of killing insects in the sapwood of sawlogs and of preventing attack show that under certain conditions it is both practical and effective.

(7) *The management principle* of preventing losses from insect depredations, as related to damage to forest products, defoliation of fir and spruce by the spruce budworm, and tree-killing insects in general, is becoming recognized as of fundamental importance in lumbering operations and general forest conservation.

## BEE-CULTURE INVESTIGATIONS.

The work of the bee-culture laboratory, under the supervision of Dr. E. F. Phillips, has been conducted along the same general lines outlined in the report of last year, namely, the emphasis of investigational work rather than educational work such as was conducted during the war. The projects under which this work is done were revised at the beginning of the fiscal year and the work is here reported under the new projects.

Behavior of bees.—Work has been begun on a study of the temperature and humidity conditions in all parts of the hive during the active season. During the latter part of the active season of 1921, temperature and humidity records were made hourly during the day, with occasional periods when records were made at night and day for several days at a time. Careful records are made of the plants that are furnishing nectar and pollen and of the hourly weights of the hive under observation. This work continued without interruption until early June, 1922, at which time certain difficulties were encountered with the thermocouples and it was necessary to discontinue the work for a short time in order to rewire the hive. The work will be continued throughout the active season of 1922. It is too early at this time to summarize the results of this work, but there can be little doubt that it will result in a better understanding of the temperature and humidity conditions prevailing in the hive during the summer. This in turn may, as in the case of the wintering work, lead to important modifications of the hive or of its management, and in any event will help to make clear the reasons for some of the phenomena which beekeepers have long observed but have not understood.

The work on the rate of increase and decrease in brood rearing is being continued.

In June, 1922, a study was begun on the responses of bees to lights of various colors and intensities. It has long been known that bees respond to numerous light stimuli, but so far no detailed study has been made on this subject, aside from some work on the responses of bees when their sight was impeded. Numerous experiments have been made on the preference of bees for certain colors, which have shown conclusively that they recognize color differences. It is hoped that the present work will clear up some of the uncertainties in this field.

At the opening of the active season of 1922, a study was undertaken of the flight of bees to and from the hive, as modified by temperature, light, the secretion of nectar, and various other external factors. This work is being done by A. E. Lundie, of South Africa, who is spending some time in the United States in a study of beekeeping. He has devised an ingenious apparatus by which the movements to and from the hive may be accurately counted automatically, and this has been installed for several months. Records of outgoing and incoming bees, of the weight of the hive, and of the temperature and other external conditions are made every quarter hour from daylight until dark daily. It is hoped that the results of this work will throw some light on certain details of bee activity so far not clearly understood.

The ability of queen bees and drones to feed themselves, without the intervention of worker bees, was established in some recent feeding experiments. While under hive conditions both the queen and drones are usually fed by the workers, they are both capable of taking food independently of the workers.

Physiology of bees.—In connection with the study of the wintering problem several years ago some feeding experiments were undertaken to determine what carbohydrates are available to bees as food.

in an effort to explain the phenomena of dysentery (spotting of feces) so frequently observed when bees are not wintering well. At that time it was learned that bees are unable to digest certain carbohydrates which are found in inferior grades of honey and in honeydew honey, and these results were incorporated in publications on wintering. The subject required additional experimentation before definite statements could be made concerning certain interesting carbohydrates, and during the spring of 1922 additional feeding experiments were undertaken. A large series of chemically pure carbohydrates were obtained and fed to bees to determine their availability as food. Most of the materials chosen were those which bees might obtain in the gathering of nectar in the flowers. It is now evident that the ability of bees to digest carbohydrates is exceedingly limited. The results obtained explain fully the cause of dysentery in winter and emphasize the need of great care in the choice of winter stores. When bees are free to fly during the summer any of these materials which they can not digest will be eliminated through the feces; but during confinement to the hive this is impossible, and the condition known as dysentery results, often followed by the death of the entire colony. Methods for the prevention of this condition have been incorporated in publications of the department dealing with wintering of bees.

Tests have been made of the insulating value of various commercial double-walled hives on the American market to determine their suitability for wintering. The results of this work have been presented for publication as a circular of the department.

The results of the experiments on wintering bees have been further worked up. There still remains considerable work to be done before the full results of the experiments on wintering bees are available for publication, but we hope to submit them in a few months.

The work on the factors influencing the aging of bees which was mentioned in the last report was discontinued at the close of the summer of 1921, but was again undertaken in the spring of 1922. For the present, attention is being given especially to the changes which occur in the œnocytes in the adult worker bee. The purpose of this work is to determine the changes which occur in bees when they wear themselves out by excessive activity, especially during the winter months, when they are confined to the hive, and it is hoped that when these phenomena are understood, remedies for the great losses caused by the death of the worn-out bees may be devised.

As was stated in the previous report, some samples of supposedly poisonous honeys were obtained and submitted to chemical analysis. This work failed to show the cause of the trouble, and during the spring of 1922 an effort was made to determine the plant which furnished this honey. In cooperation with the Bureau of Plant Industry, it has been found to be the mountain laurel. It still remains necessary by chemical analysis to determine the presence of the poisonous material in the honey. It is of the greatest importance also that a study be made to determine under what conditions this plant secretes nectar which is poisonous, for it seems evident that it does not always do so, since the plant has a wide distribution and poisonous honey is not commonly produced. The chemical work on this honey will be undertaken as soon as possible.

In connection with the wintering work several years ago, it was found that the darker grades of honey are not as a rule as satisfactory as lighter honeys for winter stores. The grading of extracted honeys according to color is also a serious problem in honey marketing, and so far no satisfactory color grades have been established, although several attempts have been made by private individuals. An attempt to bring about a satisfactory grading is now being made, in cooperation with the Office of Grades and Standards, Bureau of Agricultural Economics. It is also hoped that typical samples may be subjected to chemical analysis to determine to what extent color is associated with undesirable characteristics for winter food. The samples will also be examined to identify the pollen grains contained in them, thus checking up the statements of those furnishing the honeys as to the floral source. If these samples may be adequately studied, it will constitute the most comprehensive investigation of American honeys so far made.

Diseases of bees.—The announcement of the cause of the Isle of Wight disease of adult bees, made in December, 1920, by Dr. James Rennie and his associates, of Scotland, has greatly increased the interest in the diseases of adult bees throughout the world. During the summer of 1921, as was stated in the last report, a study was made to determine if possible whether the mite (*Tarsonemus*) *Acarapis woodi*, causing this disease, is present in the United States. The results of the study were published as Circular 218 of the department.

As a result of a conference, held March 9, 1922, a letter was written to the Post Office Department recommending that the regulations on foreign mails be amended to exclude queen bees and the accompanying worker bees from all foreign countries, except Canada. The Dominion of Canada had also taken steps to prevent the importation of all adult bees from Europe, and since there are no known cases of the Isle of Wight disease in the Dominion, there seemed no reason to prevent the free passage of bees between the two countries. Similar quarantines are established in Australia, Jamaica, and the Union of South Africa. Since the publication of Circular 218, records have been published of the presence of the disease in several parts of France, Switzerland, and Germany, and new records of the disease appeared every month during the early part of 1922. It is impossible at this time to predict the full distribution of the disease, and for the present it seems wise to prevent the importation of all adult bees from all European countries. Considerable work is now being done in Europe on this disease, and it may be possible later to recommend a further change in the regulations to permit importations from certain countries which are known to be free of this serious disease.

Following the conference on March 9, a bill was prepared for presentation to Congress prohibiting the importation of of adult bees, except for experimental purposes by the Federal Department of Agriculture and except under rules and regulations made by the Secretary of Agriculture and the Secretary of the Treasury to permit the importations from countries known to be free of any disease dangerous to adult bees. The bill was presented to both Houses of Congress, and was passed by the House of Representatives on June 5.

At the present writing it is still before the Senate Committee on Agriculture and Forestry. The chief purpose of this bill, which has the indorsement of the department, is to regulate the importation of adult bees by means other than the mails, since such importations have been rather frequent in the past. In the event that this bill becomes law it will be possible to modify the regulations from time to time as importations from certain countries are found to be necessary and safe. It will further be possible to obtain, under the provisions of this bill, importations from any country which are needed to improve the breeding stock of the United States, and at the same time to prevent the importation of the mite causing the Isle of Wight disease.

During the present summer (1922) a large number of samples of adult bees are being received and examined for the presence of the mite, and up to the time of this writing no specimens of the mite have been found in bees from the United States. This study is greatly increasing the information available regarding other diseases of adult bees in the United States.

Work on the brood diseases of bees is being continued. During the past fiscal year 1,056 samples of suspected material were received, in which were included 200 samples of adult bees. This number is slightly smaller than that for the previous fiscal year, but is much larger than for most years since samples of diseased material have been received by the laboratory. There is an increasing need for beekeepers and apiary inspectors to have laboratory diagnoses of doubtful material, and it is believed that the examination of such material is one of the most important services which the bee-disease work of the laboratory provides for beekeepers.

The investigational work on the diseases of the brood of bees has consisted chiefly of a biochemical study of healthy and diseased brood in an effort to devise more suitable media for the study of the causes of the brood diseases. So far it has not been possible to grow *Bacillus pluton*, the cause of European foulbrood, on artificial media, a thing which is badly needed in a study of this disease. Some progress has been made in improving the media used in cultivating *Bacillus larvae*, the cause of American foulbrood. The study of the composition of the larvæ at different ages has served to explain fully the differences in the behavior of the two important brood diseases with relation to the age of the larvæ attacked by them.

The study of the factors influencing the distribution of European foulbrood, to which reference was made in the last report, has been continued, but it has been found necessary to clear up certain undetermined factors regarding the honey flows from various plants before publishing the results, and this has made it necessary to delay publication. It is still found to be true that certain important beekeeping regions of the United States are free of this disease, because of the character of the honey flow, and the results probably constitute the most important advance which has been made in the control of this disease, which has caused such great losses to American beekeeping.

Regulatory work for the control of the brood diseases of bees has always been handled as a State function, and there are now laws or regulations regarding this in 35 States and in Hawaii and Porto Rico. A gradual but definite change is taking place in this work, in that it is becoming more and more educational in character. The control of European foulbrood by the exercise of police power is unsatisfactory, and even for American foulbrood there is a tendency to eliminate the regulations formerly thought essential. In this change the bureau has worked merely in an advisory capacity, but it has been the policy for a decade to emphasize the importance of educating the beekeeper, and this is bearing fruit.

Beekeeping regions of the United States.—The three Farmers' Bulletins on specific beekeeping regions of the United States, mentioned in the last report, have been published as follows: Farmers' Bulletin 1215, "Beekeeping in the clover region"; Farmers' Bulletin 1216, "Beekeeping in the buckwheat region"; and Farmers' Bulletin 1222, "Beekeeping in the tulip-tree region."

A tabulation of the percentages of the commercial honey crop of the United States from introduced and native plants has been made. It is found, curiously enough, that about half of the commercial honey crop of the country is derived from plants that have been introduced and that about three-fourths of the crop comes from plants which are not native to regions originally inhabited by the honeybee.

Demonstrations in beekeeping.—The work on this project, which occupied so large a part of the bee-culture work during the war, has been still further decreased during the past year. At present the office is cooperating with three States in the maintenance of extension specialists in beekeeping.

It is interesting to note that in almost all the States where extension work in beekeeping was begun during the war the work has been continued as a State project and there has virtually been no decrease in work of this kind, in spite of the necessity for curtailing the activity of the bee-culture office in this line. The work has proved so helpful to the beekeepers of the various States that it has been virtually impossible for the extension divisions of the various States to drop it.

The extension short courses which were so widely held immediately following the war have to a large degree been dropped. During the past year four such schools were held—two in Colorado, where no such schools had been held previously, and two in California. While it has been impossible to conduct more of these schools, they have been received so enthusiastically by the commercial beekeepers in attendance that it is evident that they fill a great need.

While there have been associations of beekeepers for many years for a discussion of their problems and an interchange of ideas, organizations for the cooperative selling of honey have been developed recently to a large degree in the Western States, to the advantage of the beekeepers of the regions covered. Organization work of this character is now extending into the East.

Miscellaneous activities.—Several articles for bee journals and other publications have been prepared during the year on subjects which do not deal directly with the investigations of the laboratory or of results which were not suitable for publication by the department.

Status of beekeeping.—The change in the status of beekeeping outlined in the last report is still manifest. The drop in honey prices following the close of the war brought on a serious situation for the beekeeping industry of the country, and in the fall of 1921 the honey market of the country was in a deplorable condition, due to the great increase in production since 1917 and to the economic condition of the country. An interesting development arose from the fact that the majority of the beekeepers of the country were unable to sell their 1921 crop through the usual wholesale channels, and to prevent a total loss many of them undertook to sell directly to consumers. More honey was sold in this way during the fall and following winter than ever before in the history of American beekeeping, and the prices obtained for the honey were much better than could have been obtained in the usual markets. This method of selling also resulted in many people buying honey who did not do so previously, and in this way much permanent good resulted to beekeeping. The rather remarkable results are shown by the fact that not only was the whole of the 1921 crop sold, but a considerable amount of honey left over from 1920 also disappeared. There was little help from manufacturers, who sometimes use honey in the making of cakes and candies, and the housewives of the country used the honey which was sold. This offers a ray of hope to the specialist beekeeper who fears the changes in wholesale prices, in that he has found it possible to sell large crops directly to the consumer. While there will doubtless be an increase in the facilities for handling honey at wholesale, and perhaps a still larger increase in the bottling of honey by commercial establishments, it is comforting to the beekeepers of the country to know that they are largely independent of such development.

## INSECT PEST SURVEY.

J. A. Hyslop has continued in charge of this branch of the bureau's work since its inception in March, 1921. The survey has now been in operation 16 months. It has filled the need that has long been felt among entomological workers for a medium through which they could be kept more closely in touch with the insect conditions in the various parts of the country, and for a permanent record of these conditions correlated with the prevailing meteorological conditions from year to year.

During 1921 the survey completed Volume I of its monthly bulletins, which consisted of 7 numbers and an index. Volume I contained 285 pages of subject matter with a 31-page index. Five numbers of Volume II have already been issued and the annual summary of the insect conditions throughout the United States for the year 1921 is now in press. The annual summary contains 51 pages of subject matter illustrated with 28 text figures showing the geographical distribution of the insects discussed and the meteorological conditions associated with the several outbreaks reviewed.

During the year over 6,000 notes have been received on insect conditions. These notes relate to 716 different species of insects representing 567 genera.

The work of the survey has attracted considerable attention not only from entomologists but from produce exchanges and information bureaus on produce futures. The agricultural press is also utilizing the information made available by the survey.

# REPORT OF CHIEF OF BUREAU OF BIOLOGICAL SURVEY.

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United States Department of Agriculture,
Bureau of Biological Survey,
*Washington, D. C., September 14, 1922.*

Sir: I have the honor to transmit herewith a report of the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1922.

Respectfully,
E. W. Nelson,
*Chief of Bureau.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

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## ORGANIZATION OF THE BUREAU.

The Biological Survey deals with the conservation and increase of game, fur-bearing animals, and birds, and with the control of bird and mammal pests. Recent investigations reveal the fact that in the aggregate wild life resources, capitalized on the basis of a 6 per cent annual income, represent an enormous sum, possibly exceeding $1,000,000,000, and through intelligent management are capable of a great increase. On the other hand, certain forms of wild life, as the stock-killing wolves and other predatory species, with many rodents, as the house rat, prairie dog, and others, annually destroy forage crops and other property exceeding $500,000,000 in value, a loss which may be largely prevented by properly directed efforts. For the purpose of handling the considerable number and variety of problems involved in such activities the bureau is organized as follows:

1. Economic investigations, Dr. A. K. Fisher in charge. This division handles the necessary investigations of injurious mammals and provides the organization and leadership of campaigns for the destruction of predatory animals and injurious rodents throughout the country. It also maintains an experimental fur farm and investigates all matters related to fur farming for the benefit of this new industry.

2. Food habits research, W. L. McAtee in charge. By authority of the Secretary, investigations of the economic relations of birds, reptiles, and amphibians were separated from the division of economic investigations in July, 1921, and made a separate division as indicated.

3. Biological investigations, E. A. Goldman in charge. Under this division investigations are made of the distribution, migration, and other habits of birds and wild animals, and of the distribution of plants and of wild life in relation to climate for the purpose

of mapping the life zones of North America. Technical laboratory studies also are made of both birds and mammals, these activities providing the basic scientific information needed in connection with the rapidly growing economic work of the bureau. Scientific information is supplied on request to other governmental departments, State organizations, and individuals.

4. Alaska reindeer and fur bearers, E. W. Nelson and W. F. Bancroft in charge. Investigations are made of the diseases and parasites of reindeer, together with grazing and herd management and breeding experiments on the mainland and in the Aleutian Islands; also through a warden service laws are enforced for the protection of the land fur-bearing animals of Alaska; and islands are leased for fur farming, and investigations made for the upbuilding of the fur-farming industry in the Territory.

5. Game and bird reservations, H. F. Stone in charge. This division covers work connected with the maintenance and supervision of a warden service on the larger reservations, building and upkeep of game-proof fences and wardens' quarters, posting of boundaries, and hay farming and feeding of elk on a large scale at the winter elk refuge.

6. Migratory-bird treaty and Lacey Acts, G. A. Lawyer in charge. Activities under this division cover the maintenance and supervision of a warden service throughout the United States and in Alaska for the enforcement of the migratory-bird treaty and Lacey Acts, the former protecting birds migrating between the United States and Canada and the latter dealing with unlawful interstate commerce in game and the supervision of importations of living foreign birds and mammals to prevent the introduction of harmful species.

## ECONOMIC INVESTIGATIONS.

The establishment during October, 1921, of a well-equipped laboratory at Denver, Colo., for investigating poisons and their preparation and use will be an important factor in increasing the effectiveness of campaigns for the destruction of predatory animals and harmful rodents. Necessary machinery has been installed in the laboratory to process or otherwise prepare all the poison needed by field parties of the bureau and cooperators throughout the country. During the year the processed strychnine prepared amounted to more than 10,000 ounces. Investigations in the use of poisons have already resulted in greatly increased effectiveness and lowered cost of operations.

Appreciation of the practical value of the methods developed by the Biological Survey for the destruction of predatory animals and injurious rodents is shown indisputably by the continuance of substantial financial support from cooperating States, organizations, and individuals, amounting to $996.379 for the year. More than 105,000 men took part in the work, and from their reports it is estimated that a saving was made of crops and live stock amounting to more than $10,000,000.

The continuous campaigns against injurious animals are gradually eliminating large gray wolves over most of their former range and will gradually wear down the numbers of all predatory species until losses from them will become comparatively small. The extermination of harmful rodents over vast areas is also only a matter of continued operations. Two counties in Arizona and four in Kansas have been completely freed from prairie dogs during the year and the numbers of rodents are being decreased year by year over a vast area.

Work at the experimental fur farm and other investigations of fur farming continue to yield information of the greatest practical value to this new and rapidly growing industry.

### PREDATORY ANIMALS.

Establishment by the bureau of definite organizations in the Western States, upon which live-stock producers call for assistance in case of serious depredations by wolves, coyotes, and other animals, and through which definite information is available as a basis for carefully projected campaigns, is steadily reducing losses of live stock from this source, which, at the time the organized work was undertaken in 1915, were estimated at more than $20,000,000 annually. These organizations, in the grazing States of the West and also in Michigan, work in cooperation with State departments of agriculture, State live-stock commissions, State game commissions, county organizations, stockmen's associations, and individuals to clear predatory animals from great units of Federal, State, and private lands used for grazing. This is accomplished by means of carefully planned trapping, shooting, and den-hunting operations and by poisoning campaigns, which have been conducted on an unprecedented scale.

Trained hunters have also been stationed along passes leading across the Mexican border to capture promptly wolves and other predatory animals as they enter this country, and arrangements have been made with stockmen in northern Mexico for the maintenance of hunters who work in cooperation with the Federal and State forces of the United States along the international border. A constantly recurring invasion of wolves from Mexico into New Mexico and Arizona is being thus successfully controlled. Similar concerted action along adjacent State borders is very effective in destroying wide-ranging animals like wolves. Cooperation with other Federal agencies, as the Forest Service, of the Department of Agriculture, and the Office of Indian Affairs and the National Park Service, of the Department of the Interior, has also been obtained in this work.

During the year an average force of 266 hunters, trappers, and poisoners was employed under bureau supervision, and many thousands of stockmen participated in the distribution of poisoned baits during the organized drives. Part of the men employed were paid by the Federal Government and part by the States and other cooperating agencies, which contributed $196,405 to the work. Hunters are required to turn in as evidence the skins or scalps of animals killed when found in condition for the purpose. Such positive evidence was obtained during the year in the case of 30,986 predatory animals, of which 687 were large gray wolves, 27,185 coyotes, 2,827 bobcats and Canada lynxes, 173 mountain lions, and 114 bears. Bears are generally regarded as game animals and are protected by some

State laws, and no effort is made to take any except individuals known to be destructive to live stock.

In addition to the dead animals secured, it is estimated that not less than 50,000 coyotes were killed in connection with the extended poisoning operations, but their carcasses were not found. Many wolves, bobcats, and some mountain lions were also poisoned. Complete returns of animals killed in poisoning campaigns are not obtainable, but the marked reduction in the numbers of coyotes over the large areas poisoned and the number of carcasses found by stockmen on their ranches and by hunters about poison stations where it has been possible to make careful observation, indicate that this number is conservative.

The killing of about 80,000 predatory animals represents a saving of live stock and game for the year amounting to over $4,000,000 on the accepted basis of computation. Skins sold during this period yielded $34,202.75, of which $22,375 was derived from skins taken during this fiscal year, making a total revenue derived by the Government from this source in excess of $283,000 since 1915.

In the poisoning operations for the year, about 1,229,000 specially prepared and highly effective poisoned baits devised by bureau experts were used. Two methods of placing the poison are employed. Small fat baits, consisting of a small piece of meat or other substance attractive to coyotes, are placed on the ground about a poison station, or the baits are studded in carcasses of sheep, cattle, horses, burros, or other animals.

The chief poisoning operations are conducted in winter, but very effective work has been done in summer in desert country, particularly around watering places. The small fat baits distributed about a poison station are especially suited to operations over plains and deserts where the climate is at least moderately warm and natural food for predatory animals is abundant. Carcass poisoning is successful on the high summer ranges, where the weather in winter is colder and the natural food supply of predatory animals is scarce. The value of this method lies in its permanency, as the poison continues effective until spring or until no part of the animal remains; and it makes possible the destruction of predatory animals over vast timbered and mountainous areas where no camp accommodations are available during the winter months and travel is impossible except on snowshoes. The poison-studded stations are established after the sheep and cattle have been removed to lower ranges and when the weather is sufficiently cold, the hunters working down the mountains behind the retiring herds. As the stock is again moved up to the summer ranges in spring the hunters go in advance to destroy all the stations that were established, in order to prevent accidental poisoning of dogs or other animals and to trap any predatory animals which have escaped the poison. Similar systematic work on winter ranges and lambing grounds has practically ended live-stock losses over great areas and has much reduced them at other places.

In a period of five weeks two Utah hunters put out a poison line approximately 300 miles long in a great loop and around their first two stations on their return found about 40 dead coyotes. A stockman wrote that these men did good work, for, as he put it, they left a string of dead coyotes wherever they went. In one locality, after a poisoning campaign, men in charge of sheep herds reported finding, respectively, 14, more than 50, and 73 dead coyotes. The county agent at Prineville, Oreg., reported over 100 coyotes poisoned on the Ochoco National Forest in that locality, and 70 were found in the vicinity of Mitchell, on the east side of the forest.

In response to a telegram from stockmen using the range at the south end of the Whetstone Mountains, Ariz., stating that there were a number of wolves destroying cattle in that range, the district inspector went promptly into the locality and put out a line of poison on the designated range, which killed three wolves and several coyotes. A hunter left to complete the work succeeded in trapping the four wolves which remained on the range, thus cleaning out the entire pack of seven adult wolves in less than 30 days. This prompt and effective action was greatly appreciated by the stockmen. Two other wolf packs which had crossed from Mexico were cleaned up, making a total of 30 wolves destroyed along the international border without allowing a wolf to drift more than 25 miles into the United States, and only one to escape back into Mexico.

Another important catch was the "Pryor Creek Wolf," which had run for at least six years on the cattle ranges of Montana, where it was noted for its destruction of calves and Shetland ponies, its deeds of cunning, and its skill in eluding traps. Two Biological Survey hunters caught it within six days after their arrival on the range where it was operating.

South of Williams, Ariz., a large grizzly bear had been killing cattle each spring for the past 8 or 10 years. Stockmen had offered bounties ranging from $100 to $500 for its capture, and many private hunters and trappers had tried to earn them. It remained, however, for a hunter employed in the Federal-State cooperative work to kill this notorious animal as it was charging him after driving off his dogs. It was stopped by a well-placed shot when within about 15 feet of the hunter. The stockmen of that district estimated that during the past four years this bear had killed between $25,000 and $30,000 worth of live stock and probably more than twice that amount during its lifetime. This was one of the few remaining grizzlies in Arizona and by far the most destructive animal living in recent times on the ranges of that State.

Three wolves were killed in September south of Meeker, Colo., the old male having taken a serious toll from stockmen and terrorized this section for the past 15 years. Another male wolf, taken with his entire family near De Beque, Colo., had caused losses to stockmen in that vicinity amounting to many thousands of dollars, and was responsible during the last few months of its life for taking about 100 calves on one ranch, or two-thirds of the season's calf crop.

Notable progress has been made in the operations against mountain lions, which in many districts are so seriously destructive to colts as to make horse raising impracticable. They also make heavy inroads upon deer and other game. Lions have been so reduced in numbers along the Blue River, in the eastern part of Arizona, that few stock are found killed by them. It is reported that there are fewer lions along this river than at any time since white men have occupied the district, and that they are scarce along the north rim of the Grand Canyon, where formerly they were very numerous. Mountain lions have been hunted chiefly with dogs and rifle, but encouraging success has been attained in poisoning operations, and they are occasionally trapped by using special scent baits attractive to them.

In Montana a hunter with his dog succeeded in killing five mountain lions between 1 and 4 p. m. on February 8 in one of the great deer yards, where the deer were found easy prey. During the period from November 26, 1921, to June 30, 1922, this hunter killed 23 lions, and another Montana hunter killed 14 during the year, one of them having been treed and shot just after killing a deer which it had not had time to eat.

### PREDATORY ANIMALS AND GAME.

As the extent to which predatory animals destroy game becomes better known, State game departments are coming to cooperate more liberally with the bureau in efforts to destroy these animals. Their destructiveness is not only to such of the larger game as deer, elk, and antelope, but also to practically all of the ground-nesting species of game birds. In Michigan the work was initiated at the request of the conservation commission, primarily in the interest of game. The work in this State is being led by an expert of the bureau, and the field operations are financed by an increase of $1 on resident and $15 on nonresident deer-hunting licenses, which, with receipts derived from the sale of furs, skins, or live animals taken by hunters, yields sufficient revenue for very effective work, costing between $30,000 and $40,000 a year. Live-stock and agricultural interests profit by the Michigan plan, as instanced in certain cut-over forest areas, where sheep growing was found impracticable until the predatory animals were destroyed. It has been estimated after careful investigation that not less than 10,000 deer are killed annually by predatory animals in that State. Timber wolves, coyotes, wild cats, and foxes all join in game destruction, the kill being heaviest in winter, when the snow is deep, and especially in early spring, after the snow becomes crusted. At this period wolves and coyotes often appear to kill for no apparent reason other than for amusement or sheer lust of killing.

A good instance of the destructiveness of deer by wolves was observed by the bureau representative in southern Marquette County the latter part of March. Evidence had been found that a pack of wolves was working in the deer yards of that section, and one night they were heard howling. The following morning investigation was made on snowshoes and the tracks of a single wolf were soon located. The trail led a short distance to a swamp, where several deer were yarding over a small area and where the wolf was joined by two others and the round of destruction begun. The remains of four freshly killed deer were found on an area of about 3 acres. Subsequent investigations disclosed that in the few weeks preceding this time probably a hundred deer in yards scattered over an area of about 3 square miles in that locality were killed by these wolves. This number does not include many unborn fawns. The wolves also worked through other yarding sections, as they spent only a part of their time in the area described.

Coyotes destroy many deer in the forested sections, where two or three working together pull down the large animals whenever the snow is deep or crusted, and appear to have much sport in doing it. Bobcats in the Upper Peninsula grow to a very large size, and the evidence is unmistakable in many cases that they kill young and even full-grown deer when the snow is deep. One hunter found three deer killed in deep snow during the early part of March by a single bobcat, which weighed 35 pounds and was trapped about the middle of the month at the carcasses.

Over some areas of the West where predatory animals have been largely eliminated there has been a notable increase in quail and grouse.

During the year organized predatory-animal field operations have been in progress in the following States: Arizona, Arkansas, California, Colorado, Idaho, Michigan, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Demonstrations also have been made for stockmen in Missouri, Iowa, and Indiana, and information regarding the most effective methods of destroying predatory animals has been given to stockmen in Louisiana, Wisconsin, Minnesota, North Dakota, and other States where serious depredations were reported and application made for assistance for which no hunters were available.

The practice of examining and recording the stomach contents of predatory animals killed in field operations has given by far the most complete record in existence of their food habits and shows conclusively the destructiveness of these animals both to game and live stock.

## RABIES.

The past year witnessed the most serious outbreak of rabies that has occurred since that of 1915 and 1916, when the disease was spread by coyotes and dogs through Washington, Oregon, Idaho, northern California, Nevada, and western Utah, causing great destruction of live stock and danger and loss of human life. The disease appeared in virulent form in Washington in the counties of Adams, Grant, Douglas, Franklin, Benton, Kittitas, and Lincoln, and was brought under control only after the adoption of most vigorous measures by the bureau's predatory-animal inspector in charge, cooperating with the State department of agriculture, the State and county health officers, and the State agricultural college. Quarantine measures were rigidly enforced, and the entire force of hunters which it was possible to maintain with regular and emergency appropriations made available for this purpose was concentrated in this region for the purpose of destroying the infected animals and possible carriers. About 1,800 coyotes were taken in five counties. As a result the epidemic was effectively controlled, but only after a considerable loss of live stock and much danger to the people of the locality.

Sporadic outbreaks of rabies also occurred among coyotes in Oregon, northern California, Nevada, and Utah. The disease made its appearance among dogs in Arizona and New Mexico, but its spread to coyotes of the locality was prevented by prompt inauguration of poisoning campaigns to destroy these animals in a wide zone surrounding the infected area. The regular recurrence of outbreaks of rabies and the serious consequences that would result should it again become widespread demonstrate the need of having experienced men ready to stamp out the disease whenever it makes its appearance.

### RODENT PESTS.

Backed by the sustained interest and strong financial support of farmers and stockmen, the work of eradicating destructive rodents on Federal, State, and private lands has progressed with increased vigor. The concerted drives conducted under the leadership of bureau specialists have proved of such definite value that this advance has been made in spite of the general tendency toward retrenchment due to financial depression. In fact, it appears that this state of affairs has served to accentuate the importance of eliminating losses in production and waste of agricultural products due to rodent pests, since this has come in many places to be recognized as a factor which often determines profit or loss on the year's efforts. The correlation of Federal, State, and local agencies into an effective cooperating working force has been continued through the States Relations Service with the State extension organizations, including the county agricultural agents and State and county farm bureaus. State departments of agriculture have participated on an increased scale through the organization of pest districts and enforcement of State laws relative to clearing rodent-infested lands. Many other agricultural, horticultural, and live-stock organizations have also taken active part. Officials of the Forest Service and of the Office of Indian Affairs and the Reclamation Service continued to cooperate in campaigns involving Federal lands under their control.

Where features affecting community health were associated with the distinctly economic problems, as in bubonic and pneumonic plagues, Rocky Mountain spotted fever, and kindred disease-producing agencies disseminated by rodents, the bureau continued to cooperate with the United States Public Health Service, of the Treasury Department, and with State, county, and municipal health organizations. Such cooperation is essential to complete success when rodents infest both the cities and villages and the rural sections.

Conspicuous damage to crops and range grasses by the larger native rodents, as prairie dogs, ground squirrels, pocket gophers, and jack rabbits, first led to the large-scale organization of this work in the Western States. The marked benefits resulting from control measures employed against these rodents led to more careful and detailed observation and the recognition of the widespread and important damage by the numerous smaller but abundant native rodents.

#### PRAIRIE DOGS AND GROUND SQUIRRELS.

In the organized campaigns against prairie dogs and ground squirrels, 17,678,041 acres of Federal and private lands were given a first treatment with poisoned baits during the year, and follow-up work to complete eradication was done on 8,004,469 acres. This makes a total of 10,164,899 acres of Federal lands and 93,345,400 acres of State and private lands which have been treated since 1916 and largely cleared of these rodents in the following States: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota Utah, Washington, and Wyoming.

The bureau assumes the cost of operation on Federal lands, State officials on State lands, and farmers and stockmen on their own holdings. Funds contributed by State and county appropriations and those expended by landowners in this cooperative undertaking during the year amounted to $799,974. Poisoned grain amounting to 1,008 tons was prepared and distributed under the direction and supervision of bureau representatives and 754,803 pounds of carbon bisulphide were used in fumigating burrows to complete the eradication of these rodents. Approximately 105,000 farmers and stockmen took active part in clearing their lands. Taking into consideration the low prices prevailing on farm and range products during the year, it is estimated that a saving of $6,000,000 was effected. The estimated annual saving of crops and range grasses since this work was instituted on a large scale in 1916 totals $60,000,000. As the lands are progressively and permanently cleared of these pests the savings effected by the annual campaigns become cumulative, permanent additions to the productiveness of the lands.

Field operations against prairie dogs and ground squirrels are being conducted with a view to the complete eradication of these rodents in a systematic manner over great units of land through such initial and follow-up measures as may be required. From 75 to 95 per cent of the animals are usually destroyed by the first poison treatment, and eradication is completed by later applications of poisoned grain and carbon bisulphide or other fumigating agents. Many counties throughout the West, previously heavily infested, have been thus cleared to a point where only an occasional animal can be found, while some counties report complete eradication of prairie dogs this year. The following extracts from a letter from a prominent stockman in Arizona indicate benefits accruing from this work:

> On June 25, 1922, the last prairie dog was exterminated from the counties of Cochise and Graham. This was the result of three years of united effort on the part of over 800 stockmen and farmers cooperating with two experts of the Biological Survey. An area 120 miles long and from 10 to 20 miles wide was actually cleared of this pest.
>
> Three years ago when I visited this district, I rode through miles and miles of prairie-dog infestation, and bare denuded lands lay on every side. To-day, after these pests have been exterminated, the grass is knee-high, fat stock and fertile farms are to be seen on every hand, and a prosperous community is in the making where heretofore at least 5,000,000 prairie dogs had their way and held in check the development of that fertile valley.
>
> It is estimated that the increased forage now made possible will support at least 50,000 head of sheep, and farmers are now growing alfalfa and grain on ground which was formerly so heavily infested with prairie dogs that it was quite impossible to raise anything.

As the county eradication campaigns reach a point where the few remaining rodents are no longer regarded as a menace there is often a tendency for landowners to slacken in the work. Definite effort is made by the bureau to have the work continued to complete extermination in order to insure against the rodents again reinfesting the lands. A number of counties which failed to push the follow-up work suffered considerable reinfestation and have now taken up the work in earnest with a view to being permanently rid of these destructive animals. The progress of the cooperative campaigns is seriously impeded, owing to insufficient Federal funds to clear Federal lands bordering private holdings. In many places this deters local activity, which would respond promptly but for the lack of money to enable the bureau to do its part.

## POCKET GOPHERS.

Demonstration through field operations that the control of pocket gophers can be accomplished has led to increased demands for campaigns against them. Work has been undertaken on a large scale in Arizona, Idaho, Kansas, Nebraska, New Mexico, Oregon, Texas, and Washington, and considerable demonstration work also was done in Florida, Missouri, North Dakota, Oklahoma, and South Dakota. A determined effort is being made in alfalfa-producing sections to destroy these animals, which cause damage to this crop commonly amounting to $2 or more an acre and often destroy the entire stand. The mounds of dirt which they throw up also interfere seriously with the operation of harvesting machinery and assume great importance in irrigated lands, where intensive cultivation of root crops, orchards, and vineyards enables these animals to work havoc. As the damage occurs under ground, it is often irreparable before it is noticed. Only by knowing the possibility of injury on infested land and destroying the animals can this be avoided. Pocket gophers are being eradicated successfully through the employment of various vegetable, grain, alfalfa, or clover baits treated with strychnine and placed in the runways, and by the use of specially designed traps.

Producers of citrus fruits in the Salt River and Yuma Valleys of Arizona, where heavy losses were experienced, have been able completely to protect their orchards from pocket gophers by the methods employed in the campaigns inaugurated last year. It is estimated that over 1,200,000 of these rodents were killed in Arizona this year. In a recent contest, directed by the bureau representative, which took place in the Salt River Valley, Ariz., 1,135 schoolboys were provided with pocket-gopher traps and shown how to use them. By actual count they caught over 36,000 of these animals, the tails being retained as evidence. The winner caught 1,450. The contest cost $180 in prizes; but the county formerly paid 5 cents bounty on pocket gophers, so that $1,620 was saved the taxpayers on this drive alone, aside from the protection afforded the crops.

Pocket gophers are among the worst of our native rodent pests. Their destruction of crops and their burrows in irrigation canal banks, which cause serious washouts, build up an enormous annual loss to farmers. The work done in pocket-gopher control in Dona Ana County, N. Mex., last year, in which losses of this character, estimated at $60,000 a year, were eliminated at a total cost to the farmers of about $3,500, proved so successful that field operations have been extended to other portions of the Elephant Butte project, both in New Mexico and Texas, with a view to covering completely this important irrigation area. Approximately 140 miles of canal banks were treated with poison in 2 counties in Idaho, in conjunction with work done on farming lands in 11 counties of that State, where 79,000 acres of private lands were treated.

## JACK RABBITS AND COTTONTAILS.

Particularly effective campaigns against jack rabbits were conducted in Idaho, Oregon, Washington, Nebraska, Utah, Arizona, and Texas under the favorable weather conditions which prevailed during the past winter. Where these animals were proving seriously destructive to alfalfa, cotton, hay, muskmelon, lettuce, grain, and other crops they were killed in great numbers by means of organized drives and the use of traps and poison. In 10 counties of Idaho 32,235 pounds of bait treated with 2,159 ounces of strychnine were used on 312,350 acres of land. By poisoning and by drives, 640,050 jack rabbits, by actual count, were destroyed there. In 6 counties of Washington 155,500 jack rabbits were reported killed by poison, trap, and drive, 1,873 in one night by the use of 4 ounces of strychnine alkaloid dusted on 30 gallons of sliced apples. In Oregon it is estimated that 350,000 rabbits were killed in four counties where this work was undertaken, 58,300 being actually counted as a result of poisoning operations in the vicinity of Fort Rock. In three counties of Texas, 35,060 jack rabbits were killed by drives and the use of pens in which poisoned baits were placed after prebaiting at these places with alfalfa or maize heads to get the animals accustomed to feeding there.

Damage to orchards, vineyards, and agricultural crops by cottontail rabbits continued to be reported from many points throughout the country, and instructions for the control of these animals have been furnished.

### MEADOW MICE, PINE MICE, POCKET MICE, AND KANGAROO RATS.

Although small in size, various kinds of native mice, under favorable conditions, become excessively abundant and do serious damage in orchards, gardens, and truck farms. During the year meadow mice appeared in destructive numbers in many of the important orchard sections of Idaho and Washington. Where this condition was foreseen in time, the use of poisons recommended by the bureau prevented serious damage, but in many localities where poisons were not used the loss of trees was heavy. Investigations made through the area infested by pine mice disclosed the fact that damage by these small underground animals was very great and widespread, irreparable injury to orchards often being done when the ground was covered with snow. Losses of sweet potatoes, white potatoes, and other root or tuber crops were also exceedingly heavy, and much damage to flower bulbs was reported. Pocket mice were found to be destroying as much as 3 bushels of grain an acre in two counties in the State of Washington. The damage was done by eating the planted grain and by cutting off the ripened heads at harvest time. Effective work was done by poisoning these mice where their abundance and destructiveness warranted.

Considerable assistance has been given landowners in the control of kangaroo rats, through demonstration of practical methods. Where these animals are found in large numbers, as in the sandy regions of the Southwest, they cut the grass and interfere materially with natural reseeding of the range by destroying great quantities of seed of the native forage grasses. Areas from 20 to 30 feet in diameter about their burrows are often completely denuded of grass, and where the rats are numerous they thus cause a reduction of 10 to 20 per cent in the carrying capacity of the range. They also make raids on fields of sprouting grain, thus reducing the amount and the value of the crop harvested.

### WOODCHUCKS.

An unusually large number of complaints of excessive abundance of woodchucks and damage by them have been received during the year from points in the Eastern States. These animals also continued to be destructive in the Northwestern States to alfalfa and cultivated crops in the narrow valleys surrounded by rocky promontories amid which they live. One farmer writes that they entirely cleaned up 40 acres of wheat and 10 acres of alfalfa and took newly seeded corn out of 2 acres of ground. Demonstration of effective methods for destroying the animals has enabled landowners greatly to reduce losses. In one demonstration in which 1 ounce of strychnine alkaloid was used to poison green alfalfa tops 81 dead woodchucks were found.

### HOUSE RATS AND MICE.

Information furnished by this bureau through bulletins and special articles on the destructiveness of house rats and mice, the danger to health involved in their presence, and practical methods for their control has been very widely used by magazines, farm journals, and newspapers, and by educational workers and public-spirited citizens in bringing the necessity for active control measures to the attention of individuals and communities. Public sentiment was developed until there is apparent an ever-increasing intolerance of the presence of these animals and the waste due to their depredations. The brown or house rat overshadows all other rodent pests as a waster of food and destroyer of property and as an agent in the dissemination of such serious communicable diseases as the bubonic and pneumonic plagues in man, trichinosis in swine, and avian tuberculosis in domestic poultry.

A survey made during the year of conditions of rat infestation in 27 States east of the Mississippi River showed that rats and their depredations were a problem common to all, complaint against them being as great in New England as in the Cotton Belt, and protests being equally numerous along the Atlantic seaboard and in the Corn Belt. Continual variations of the problem were encountered as specific instances of rat damage peculiar to individual localities were disclosed. Similar study of conditions in States west of the Mississippi River has shown the widespread and serious character of the rat problem in the Middle Western States and along the Pacific coast. Many local campaigns against rats have been waged throughout the country during the past year, and the bureau has responded to innumerable requests for information, for practical plans of organization, and for effective methods of combating these animals in concerted community efforts. Results thus far obtained emphasize the need of trained leaders in order to secure the proper coordination of local and State organizations, and the employment of methods best adapted to meet the varied situations presented. The bureau has endeavored, so far as practicable with available funds, to meet this need by assigning its specialists in rodent control to render this service to communities requesting help. Further educational effort is of the utmost importance to acquaint the public more generally with the economic losses and menace to health due to the presence of rats and with effective methods of combating them.

In Utah the representative of the bureau cooperated with the extension service of the agricultural college and with the State superintendent of public instruction in presenting these matters effectively. A State committee was created to combine the efforts of all organizations into a State-wide movement, and similar committees were appointed in the public schools and school districts. Teachers in the schools made this a feature of their regular programs, specific phases of the matter being covered by the various subject groups, as classes in English, art, manual training, civics, biology, and hygiene. More than 125,000 people cooperated in the campaign, and there were distributed 15,000 Farmers' Bulletins on rats, 25,000 circulars giving directions for trapping, and 20,000 circulars containing specific instructions on methods of control; 6,000 students received special demonstrations, 37,000 posters were made in the schools, 30,000 essays were written on the subject, and 29,000 educational questionnaires were circulated; 1,250 pounds of barium carbonate were used in poisoned baits. Newspapers were liberal in giving the campaign publicity and in printing special articles on the subject of rat control.

A somewhat similar undertaking was launched in Iowa on request of interested citizens and organizations. An experienced representative of the bureau was detailed for a short time to work on educational material and outline methods adapted to conditions in this important agricultural State. The work was taken up actively by the extension service of the agricultural college, by newspapers of State-wide and local distribution, and by farm journals. The interest aroused by these efforts, both in Iowa and other States reached by the material issued, resulted in the destruction of great numbers of rats and the adoption of means for preventing rat infestation of farm buildings.

Special attention was given the requirements of poultry raisers in western Washington, both by means of demonstrations and by the issuance by the local bureau representative, through the State agricultural college and experiment station, of a circular prepared to meet the specific problems regarding rat control in poultry plants.

Investigations were conducted during the year for the purpose of improving procedure in combating rats by trapping, poisoning, ratproof construction or repair of buildings, elimination of rat harborage, and the proper disposal of garbage and other sources of rat food. Special investigations were made regarding the effectiveness of the various rat viruses on the market and extensively advertised as a panacea for rat riddance. This work was carried on in cooperation with the experiment station of the North Dakota Agricultural College and with the Bureau of Animal Industry, of the Department of Agriculture. The experiment station published a circular setting forth the results obtained in the tests made at the station. All the results obtained in connection with these investigations and a large percentage of the reports from users of these products throughout the country indicate that such viruses are generally unreliable, and at their best the cost is out of all proportion to the destruction of rats that may be accomplished by their use.

### MOLES.

Complaints concerning damage by moles in lawns, gardens, and truck farms have received attention, and much of the damage reported has been found to be due to mice following in the mole runways. This is generally the case where sprouting grain, vegetables, and flower bulbs are being eaten. Moles do real damage by lifting up the soil into ridges, so that grasses or other plants are killed by the breaking or drying out of the roots. This is the more common type of injury in the Eastern States. In western Washington and Oregon and in northwestern California, moles, in connection with their burrowing activities, also pile up mounds of dirt which cover and destroy crop or forage plants and interfere with the use of harvesting machinery. Where complaints of this kind were received, practical methods of control were supplied through correspondence, published material, or demonstrations.

### PRODUCTION OF DOMESTIC RABBITS.

Considerable interest has continued in the production of domestic rabbits as a source of meat and fur. The bureau has kept in touch with leading rabbit producers and officials of National and State organizations of rabbit breeders. Information has been furnished regarding the care, feeding, and management of rabbits, and, in cooperation with the Bureau of Markets and Crop Estimates, regarding practical procedure in developing a market for the animals produced.

### FUR-BEARING ANIMALS.

Important progress has been made in investigations pertaining to the rearing of wild fur-bearing animals in captivity. The rapid development within the United States of the industry of rearing silver, black, and cross foxes has necessitated efforts to work out practical methods for handling the problems constantly confronting the fur farmer regarding the health of the animals in captivity. During the year a large percentage of the fox farms in this country and Canada were visited by experienced representatives of the bureau for the purpose of studying practices of feeding and management employed and conditions affecting the health and fecundity of the animals, and of conferring with fox ranchers regarding problems requiring solution. Because of the great interest manifested in this work on the part of those engaged in the industry a bulletin is being prepared embodying an analysis of conditions found and suggestions for their improvement.

A questionnaire was sent out in the spring of 1922 to persons engaged in raising fur-bearing animals in the United States, in order to obtain comprehensive information regarding the extent of the industry, the success attained, and the capital invested. It has proved somewhat difficult to gather complete and authentic information, as some breeders appear to be suspicious or neglectful and fail to fill out and return the blanks.

The fur farms reporting were distributed through the following 25 States: California, Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Texas, Vermont, Washington, and Wisconsin.

The imperfect returns furnish the following data regarding animals now being reared in captivity and the number of persons engaged in the business:

| Fur animals. | Number of breeders. | Number of animals. | Fur animals. | Number of breeders. | Number of animals. |
|---|---|---|---|---|---|
| Foxes | 231 | 6,702 | Martens | 6 | 74 |
| Skunks | 46 | 1,947 | Muskrats | 5 | ........ |
| Raccoons | 27 | 131 | Squirrels | 3 | 86 |
| Minks | 19 | 170 | Beavers | 1 | 10 |
| Opossums | 8 | 86 | | | |

Judging from these figures and from observations made in the field by representatives of the Biological Survey, it is estimated that 500 ranchers are raising silver foxes in the United States; that they have between 12,000 and 15,000 foxes in captivity; and that the value of the investment is about $8,000,000.

Studies of fur bearers have been continued at the experimental fur farm at Keeseville, N. Y. The animals confined there are red and cross foxes, skunks, and martens. Experiments have been made in the feeding, housing, and management of these animals. The major part of the work, however, consisted of a study of the diseases and parasites which affect fur bearers and methods of control.

Progress was made in studies of the prevalence of internal and external parasites of foxes, in determining effective agents for their removal from infested animals, and in improving methods of administering remedies. Extended studies have been made regarding the tolerance of foxes to varied remedial drugs in order to determine safe and effective dosage at various ages and under varied states of health.

Examination of 446 fecal samples from 43 different fox ranches indicates that internal parasites are very prevalent. The most important parasites found are hookworms, roundworms, lung worms, flukes, tapeworms, and coccidia. Valuable information has been obtained regarding the occurrence of such parasites among wild foxes. Investigations of the relative susceptibility of fox pups at various ages to infestation with internal parasites, as compared with the adults, and of the seasonal variability in the abundance and the symptoms of parasitic infestation have yielded important information.

Studies have been continued of the physiology of foxes both in health and disease for the purpose of obtaining information regarding pulse, respiration, and temperature, and the variations of these at different ages and under differing conditions of excitement and health. Such information is required for a proper understanding of conditions existing in healthy animals and for the detection, diagnosis, and treatment of disease among them.

Experiments have been made regarding types of pens with improved sanitary features to ascertain their value in reducing disease, parasitic infestation, and mortality among young and adult foxes. Other experiments have been conducted to determine the effectiveness of climatic agencies and the time interval required for these to destroy the eggs and larvae of parasites present in the pen soil. Results indicate that little reliance can be placed upon time to overcome infestation.

### BREEDING SEASON OF THE MARTEN.

The discovery at the experimental fur farm that martens breed the last of July and in August has solved the problem which has heretofore prevented the successful rearing of these animals in captivity. The belief has been that these animals mate late in fall or in winter and that they could not be kept together during the summer season, and following this theory efforts to breed these animals in captivity have been unsuccessful. Martens have been bred on the experimental fur farm in August during the last three seasons and the period of gestation has proved to be about eight months. This discovery, together with the determination made regarding feeding and management, has made practicable the rearing of another of our valuable fur bearers in captivity.

## FOOD HABITS RESEARCH.

The work of this division has centered about the relations of birds to agriculture, but progress was made also on an economic study of toads, and numerous stomachs of mammals were examined. During the year arrangements were made with three States for preserving the stomachs of animals killed as vermin by game wardens and employees of game farms. By means of this cooperation it is hoped to get a good basis of fact for discussion of the vexed vermin problem, consideration of which in the past has been based largely on conjecture and speculation.

A small auto truck and two motor cycles procured for field use have proved highly economical and effective aids to the work. The cost of operation has been surprisingly low, and the results show not only a very great economy over the use of common carriers but much more work accomplished, owing to the attendant freedom of action and elimination of delay.

### CONTROL OF PINYON JAYS DAMAGING GRAIN IN COLORADO.

Pinyon jays, inhabiting the Rocky Mountain States, are birds of the same family as crows and about half their size. Between nesting seasons they rove in large flocks, sometimes containing thousands of birds, and wreak havoc on grain crops. Experiments in methods of control of these birds when attacking corn were entirely successful in west-central Colorado, and a leaflet containing directions for using a simple but effective poison formula has been distributed in that territory. Plans are being laid for studying the relations of the birds to wheat during the coming fiscal year.

### BLACKBIRDS AND DUCKS IN RELATION TO GRAIN IN THE IMPERIAL VALLEY, CALIF.

Milo maize and barley, grain crops of the fertile Imperial Valley, Calif., attract immense flocks of blackbirds, which feed upon them throughout the fall and winter months. Investigation by a representative of the Biological Survey revealed an average destruction of about 10 per cent of the crop over an area of 20,000 acres. This damage, together with lesser losses inflicted in adjoining areas, added to expenditures for protection of the grain, totals about $50,000 as the annual loss to the valley from blackbird depredations. An assistant experimented for several months with poisons, and, although occasional big kills were made, the results on the whole indicate that poisoning can not be depended upon for control. The possibility of employing toxic gases has been considered, but their practicability is doubtful. Meanwhile the expensive task of "bird-minding" is practiced, and while this alleviates the losses it is not an economical method of control.

Wild ducks, also, finding the irrigated fields of the Imperial Valley a tempting feeding ground, are especially destructive to newly sown barley and alfalfa. Examination of numerous stomachs showed that barley was the source of more than two-fifths of the food of pintails, about three-tenths of that of mallards, a fourth of that of widgeons, and a fifth of that of green-winged teal resorting to the barley fields. Three-tenths also of the food of the widgeon was alfalfa. Ducks cause damage not only by eating seed grain and alfalfa, but by their puddling method of feeding, which results in so compacting the soil that nothing will grow upon it until after it has been renewed by thorough cultivation. The ducks feed at night, and it has been found that operating automatic flash guns, together with firing blank shotgun cartridges, affords a considerable degree of protection to the crops.

### WILD FOWL DESTRUCTIVE TO SHELLFISH IN MASSACHUSETTS.

Complaints that certain wild ducks destroy large numbers of commercially valuable shellfish in Massachusetts have been received from time to time, the season of greatest damage being alleged to be in midwinter, particularly during January, following the close of the shooting season. A representative of this bureau was detailed to make an investigation of the matter during the months of December, January, and February. All the important shellfishing grounds of the State were visited, testimony was taken, observations made, and specimens collected. Of the 11 species of wild fowl of which stomachs were collected, none had eaten a significant quantity of any commercial shellfish other than the common mussel and the scallop.

Since the mussel is so abundant everywhere and has only a limited sale, feeding of the birds upon it is of little consequence. The scallop, however, has an extensive market and usually brings a high price, the level of which is kept by the trade as near the maximum as possible. The inquiry as to damage to the shellfish industry, therefore, resolved itself into a study of the relations of wild fowl to a single species—the scallop. Of the 11 kinds of birds collected, 4—the murre, brant, red-breasted merganser or pheasant sheldrake, and the purple sandpiper or rock bird—had taken no scallops; and two others—the old squaw and whistler—made them only about 1 per cent of their food. Scallops composed 3.17 per cent of the food of 24 greater scaup ducks, 5 per cent of that of 44 eider ducks, 7.83 per cent of that of 12 black ducks, 20 per cent of that of 5 American scoters or butter-billed coots, and 44.43 per cent of that of 219 white-winged scoters or coots.

On account of the small proportion of scallops taken and the general habits of the species, it is not thought that the scaup, black duck, and eider are a menace to the scallop industry, nor have they been so accused. This reduces the problem to the status of the scoters, or coots, as enemies of scallops. Of the two species of these birds, the yellow-billed or butter-billed coot is not so hardy as the white-winged, and at the season damage to scallops is said to be the greatest—that is, the most severe part of the winter—comparatively few of this species are present. The white-winged scoter, however, is abundant, and at the season investigated makes almost half of its entire food of scallops. In the absence of any good done to offset this harm, the economic status of the white-winged scoter is bad, and what should be done about it is the problem.

Fishermen wish the open season extended so that they may shoot the birds, but it is inexpedient and impracticable to extend the season on a single species of duck. To extend the season on all species would be unwise, for most of the birds need all the protection they now receive. To shift the season to cover a later period conflicts with the interests and expressed desires of a large number of hunters of migratory wild fowl in Massachusetts. It would appear, however, that a remedy of this kind is unnecessary, since the scoters and other wild ducks are easily driven away from the scallop beds by running a boat near them. They feed on the beds only by day, and hence they can be rather easily controlled. It would seem that the scallop fishermen should be willing to undertake the small cost of patrolling the waters over the scallop beds from which their income is derived, but for the upkeep of which they are usually at no expense.

### BIRDS INJURIOUS TO SMALL FRUITS.

Investigations of fruit-eating birds in Oregon, Washington, and Colorado were concluded early in the fiscal year. The birds involved in the Northwestern States were robins, band-tailed pigeons, purple finches, woodpeckers, and blue jays. The last-named birds are not protected by law, and permits have been issued when necessary for the destruction of robins and band-tailed pigeons. The other birds were not found seriously destructive. In Colorado also the robin was the species most injurious to small fruits, with magpies, band-tailed pigeons, woodpeckers, orioles, and tanagers of less importance. The magpie is not protected by law and robins may now be killed under permit. Modification of the protected status of the other birds concerned seemed unnecessary.

### SURVEYS OF THE FEEDING GROUNDS OF WILD FOWL.

In continuation of the investigation of feeding grounds of wild fowl, work was begun among the very numerous and important lakes and marshes of Minnesota. Progress was made in the survey and information furnished to interested persons on the value in their natural condition of lakes involved in proposed drainage operations. Reports have been prepared on the previous seasons' surveys.

### MISCELLANEOUS WORK IN ECONOMIC ORNITHOLOGY.

An assistant visited Fishers Island, N. Y., in September to observe the notable flights of hawks, to study the relation of these birds to a pheasant farm there, and to collect specimens. The trip was moderately successful, but weather conditions were not propitious for the usual large flights.

In furtherance of a cooperative project with the Chemical Warfare Service, Edgewood Arsenal, Md., was visited for the purpose of planning equipment and procedure for an investigation of the possible usefulness of toxic gases in the control of injurious birds.

An illustrated lecture on "The value of birds to agriculture" supplied by the bureau to the States Relations Service at an earlier date for distribution was in good demand. During the latter half of the year 14 sets of slides were sent out, each accompanied by a copy of the lecture, several of them on circuits where they were in daily use for a month or more.

### EXAMINATION OF STOMACHS OF BIRDS.

Work was continued on the English sparrow, the contents of about 800 stomachs being analyzed. Examinations of various groups of shorebirds were kept up to date, a considerable accumulation of material representing the various species of plovers was disposed of, and about 700 pellets of owls were examined.

Numerous special examinations of bird stomachs for correspondents were made, as in former years. Notable collections received in this way contained the stomachs of pileated woodpeckers, pigmy owls, and rough-legged hawks from Oregon; ruffed grouse from Wisconsin; great blue herons from Michigan; bobwhites from South Carolina; black swifts from Washington; and wild ducks from Peru.

### WORK ON THE FOOD HABITS OF TOADS AND MAMMALS.

Nearly 600 stomachs of 3 species of toads were examined during the year. Toads are notable for taking a great variety of food, and in 500 stomachs of the common toad (examined in this and preceding fiscal years) no fewer than 1,200 food items were identified. This great diversity of food makes the work slow and tedious. During the year a leaflet was prepared summarizing the economic status of the common toad, with some notes on its habits, and another on poisonous snakes of the United States was manifolded and distributed.

More than 300 stomachs of mammals were examined, including chipmunks, pocket mice, rabbits, moles, shrews, bears, caribou, mountain sheep, moose, and deer. Knowledge of the food of grazing animals is of considerable value in connection with the bureau's investigations of the reindeer industry in Alaska and in determining the relation of the feeding habits of big game to live-stock grazing.

## BIOLOGICAL INVESTIGATIONS.

In general, the technical work of this division has continued along lines supplying the definite basic information required for the proper discharge of the various duties of the bureau, such as the enforcement of the migratory-bird treaty and the Lacey Acts, the administration of mammal and bird reservations, the conservation of game birds and mammals, and lines bearing upon the relations of birds and mammals to agriculture, forestry, and animal husbandry. The biological surveys of States and field operations in general have been curtailed, owing to the limited funds available. Notable additions have been made to the various information files and card indexes on the distribution, abundance, and habits of North American birds and mammals, the accumulating data yearly affording more complete knowledge of the life histories and complex relations of wild life to human welfare. These files, containing information gathered from many sources, increase steadily in value and are indispensable in conducting the work of the bureau. They are constantly being consulted to furnish information sought by other governmental departments, State officials, scientific and other institutions, and individuals throughout the United States and many foreign countries. Noteworthy advance has been made in the banding of birds as a means of obtaining exact information concerning their migrations, which is of special value in connection with the enforcement of the migratory-bird treaty act.

### BIOLOGICAL SURVEYS OF STATES.

Because of limited funds, field-survey work was continued only in the State of Washington. A field party operated in the Olympic Mountains, mainly in the higher sections and on the northern slopes of this isolated mountain mass. The State College of Washington, which is cooperating with the bureau in this survey, had a representative with the party a part of the time from the first of July to the end of September. During October, November, and December, a field representative of the bureau continued work in various scattered localities, chiefly east of the Cascade Mountains, and practically completed the biological survey of the State. With the completion of field work the preparation of the final report was undertaken.

Progress was made in the preparation of faunal reports, especially on the "Mammals of Wyoming" (nearly completed) and the "Mammals of Oregon." Technical studies of mammals were continued during the year and systematic revisions of the shrews and chipmunks were well advanced.

### DISTRIBUTION AND MIGRATION OF BIRDS.

Work dealing with bird migration has been carried on as in previous years, and the number of voluntary observers reporting on the subject was about 250, including some new observers from the Southern and Western States, regions from which reports are greatly desired. Considerable progress has been made in abstracting records from published sources, and the copying of the field notes of various members of the survey is now up to date. The number of record cards in the distribution and migration files is now nearly 1,500,000. Considerable work has been done on the bird collection in identifying, carding, and arranging material of recent acquisition.

### BIRD COUNTS.

Reports of bird counts numbered about 55, a slight increase over those of last year, and included many made on the same areas as in previous years, which form a valuable and exceedingly important series. The third report on bird counts in the United States, which covers the years 1916 to 1920, inclusive, was prepared for publication.

### BIRD BANDING.

The bird banding work has made substantial progress during the period covered by this report. At the close of the year the cooperators enlisted in this project numbered 490, and the number is being continually augmented as the interest increases. Cooperation is being extended by various State organizations, including game commissions, colleges, and universities.

Perhaps the most noteworthy feature of the past year has been the great interest developed in the New England States, especially in Massachusetts, which resulted in the formation in January of the New England Bird Banding Association, organized for the purpose of increasing interest in bird banding and furthering the cooperation of individuals and organizations with the Biological Survey. A representative of the bureau was present at the organization meeting to arrange for the proper coordination of the activities of the new organization with the work of the bureau.

The number of birds banded under the direction of the bureau during the year was about 6,000, and much valuable information has been obtained from "return" and "repeat" records, numbering about 2,500. It is anticipated that these numbers will be greatly increased as the work develops. The work done during the year included the systematic trapping and banding of land birds, the banding of fledglings, and particularly the banding of waterfowl for the purpose of obtaining information for use in the administration of the migratory bird treaty act. Three field trips were made in the interest of bird banding work. The first, to North Dakota, in July and August, was made in cooperation with a collaborator of the bureau, and during its continuance experiments were carried on at several points in an endeavor to devise proper methods to be employed in banding waterfowl during the nesting season. The second trip, in January and February, was for the purpose of banding waterfowl near the Mississippi River in Iowa, where large numbers of ducks had congregated and remained during the winter; some work was also carried on in Missouri for the same purpose and for obtaining motion pictures of trapping and banding operations. The third trip, in February and March, was made to band waterfowl along the Illinois River near Browning, Ill., chiefly on the grounds of the Sanganois Club, in cooperation with the owners of this hunting preserve. During these trips important results were obtained in the banding of waterfowl, and the banding of these birds will be continued during the coming year. A few articles relating to bird-banding work were published through outside ornithological mediums, and two mimeographed circulars under the title "Bird banding notes" were issued to collaborators for the purpose of furnishing them information needed in carrying on the work.

### INVESTIGATIONS OF MIGRATORY WILD FOWL.

Investigations of migratory wild fowl have been continued in cooperation with State game officials. Considerable information on the breeding and mating of ducks and geese in the United States and

Canada was obtained from sportsmen, naturalists, and State game officials, which will be of particular value in carrying out the provisions of the migratory-bird treaty act. All the data were carded and made available for use. Furthermore, a card catalogue of all the birds collected under scientific collecting permits was made, including the records from 1918 to 1920, inclusive, covering the years during which Federal permits of this character have been issued.

The gratifying increase in numbers of ducks reported from many parts of the country is ascribed largely to the protection accorded under the Federal regulations prohibiting spring shooting, which formerly seriously interfered with the mating and breeding of the birds. Insistent demands have been received from certain Middle Western sections, especially in Missouri, that a spring shooting season be granted extending from February 10 to March 10, which would include the height of the spring migration, the hunters asserting that as the birds are not mated no harm would be done. In order definitely to establish whether or not the birds are mated at that season in Missouri, an assistant of the bureau was sent to the State early in February with instructions to observe the birds, kill a certain number, and make examinations of their reproductive organs. By February 21 mallard ducks in numbers were constantly seen in pairs, and enlargement of the breeding organs was clearly shown by examination of two females killed March 8 and of two males killed March 9. Still more decided increase in the size of these organs in both sexes was shown by several specimens taken March 17. The evidence was clear, therefore, that mating was in progress during February and March.

A member of the staff was sent to McGregor, Iowa, in August to represent the Biological Survey at the American School of Wild Life Protection. During the session of the school considerable information was disseminated in regard to the bird-protection work of the bureau, and close cooperation was established with this school, which is rapidly becoming an important factor in wild-life protection in the Mississippi Valley.

### WILD LIFE IN NATIONAL PARKS AND NATIONAL FORESTS.

In September an investigation of the conditions affecting game at that season on the Wichita National Forest and Game Preserve was made by an assistant of the bureau in cooperation with the Forest Service, with special reference to determining the carrying capacity of the range and developing a program for disposing of surplus animals, particularly buffalo and elk. A second visit was made early in March to observe winter conditions on the area.

At the suggestion of Gov. Robert D. Carey, of Wyoming, a joint investigation was made in February and March by representatives of the bureau, the State game department of Wyoming, and the Forest Service of the problem of obtaining sufficient winter forage for elk. This work was centered chiefly in the upper Wind River and Jackson Hole sections of Wyoming, and the joint recommendations made by the party will form the basis for further cooperation of Federal and State agencies in efforts to check the rapid diminution in the number of elk in this region.

An assistant of the bureau attended the Georgia Forestry Convention at Macon in June and delivered an address on the relation of forestry to wild life in the South, stressing especially the importance of controlling forest fires, which are destructive not only to forests but also to valuable wild life. On request of the department of game and fish of Georgia an examination was made in June of conditions on Blackbeard Island, where deer were alleged to have become excessively abundant under the complete protection afforded by an executive order. Adjustment of the matter was pending at the close of the year.

### LIFE HABITS OF INJURIOUS ANIMALS.

Studies of the life habits of animals were continued during the year, especially the food habits of certain injurious rodents, because of the urgent need of more intimate knowledge of the relations of these animals to agriculture, forestry, and stock raising. The information thus gained is of special importance in efforts of the bureau to develop improved methods of control or eradication of rodent pests.

Field investigations of beavers were made in Washington, Minnesota, Wisconsin, Michigan, and New York. Complaints had reached the bureau from various places, especially in the Adirondack Mountains, N. Y., of extensive damage by the beaver, in response to which studies were made with a view to the control of this valuable fur bearer and its utilization in fur farming. As a result of these investigations a bulletin covering the economic status of this animal was prepared and is now in press.

In Washington and Oregon field studies of pocket gophers in progress were practically completed at the end of the year. An account of the life habits and economic relations of the so-called mountain beaver, or sewellel, based largely on work in Washington, is nearly completed. In Arizona a part of the month of October was devoted to checking results of investigations in and about experimental plots established in cooperation with the Forest Service, the Carnegie Institution of Washington, and the University of Arizona, to determine the effect of native rodents on forage production and the carrying capacity of stock ranges.

### PROTECTION OF LAND FUR-BEARING ANIMALS IN ALASKA.

The work of protecting land fur-bearing animals in Alaska has been carried on so far as possible with the limited appropriation and under the inadequate fur law now in force. On September 10, 1921, new regulations for the protection of land fur-bearing animals in Alaska were promulgated, the most important change being the opening of the season on beaver and marten; there had been no open season on beaver since 1910 and none on marten since 1916. The new regulations lengthened the open season on muskrat in district No. 1 one month in spring, to April 30, and also prohibited the destruction of beaver houses or runways by the use of dynamite or other explosives or in any other manner.

Fur-warden service has been continued through the chief fur warden at Juneau and through wardens and deputies at Unalakleet, Fairbanks, Unalaska, Akutan, and Tyonic, and in the States at Seattle and Tacoma, Wash. With the opening of the season on beaver and marten, the warden service at San Francisco was discontinued. In addition to the bureau's own force of fur wardens, excellent cooperation has been extended by the Customs Division of the Treasury Department and by agents of the Department of Justice in Alaska.

### SEIZURES OF FURS.

Because of the inadequate law under which prosecutions must be made for violations of the fur law and the regulations thereunder, there have been few arrests and seizures of furs and fewer prosecutions. The use of poisons, trapping out of season, and the destruction of beaver houses are the most serious problems to contend with under the law now in operation. Unless a new Alaskan fur law is soon enacted, an acute situation will develop as to the future supply of land fur-bearing animals, one of the most valuable natural assets of the Territory.

Of nine seizures made of contraband furs, two were later released because of insufficient evidence. Furs seized included skins of 165 beavers, 96 martens, and 2 red foxes (unprime). Five convictions for illegal beaver trapping were secured, each resulting in the imposition of fines. The proceeds from the sale of seized furs during the year amounted to $3,304.43.

### SHIPMENTS OF ALASKAN FURS.

Shipments of furs from Alaska covering the period from December 1, 1920, to November 30, 1921, as reported by postmasters and agents of transportation companies in Alaska, were considerably below those of the previous year—due no doubt to trappers holding their furs because of the prevailing low prices. The value of the land furs shipped, exclusive of pelts of blue and white foxes from the Pribilof Islands (under the jurisdiction of the Bureau of Fisheries), amounted to $762,296.52, being $317,272.34 less than for the previous year. The number of the principal pelts shipped and their value are as follows:

| Kind of fur. | Number. | Value. | Kind of fur. | Number. | Value. |
|---|---|---|---|---|---|
| Muskrat | 218,737 | $273,421 | Beaver | 236 | $4,248 |
| Blue fox | 738 | 73,800 | Otter (land) | 1,174 | 29,350 |
| White fox | 2,108 | 63,240 | Mink | 18,091 | 180,910 |
| Red fox | 2,497 | 44,946 | Marten | 676 | 20,280 |
| Silver-gray fox | 183 | 32,025 | Weasel (ermine) | 6,786 | 4,071 |
| Cross fox | 371 | 11,130 | Black bear | 719 | 10,785 |

### PATROL SERVICE IN SOUTHEASTERN ALASKA.

The bureau's seagoing power boat *Regal*, used in the waters of southeastern Alaska, has been rechristened *Sea Otter*. It has a heavy-duty gasoline engine, and as it is one of the best of the patrol boats in those waters it will make it possible for the chief fur warden to visit the entire coast line for securing better observance of the law and investigating the fur farms on many islands to help establish this growing industry on a sound basis.

## FUR FARMING IN ALASKA.

All but 2 of the 10 islands off the southern coast of Alaska under the supervision of the bureau are under lease for fur farming. The lease on Chowiet Island was canceled at the request of the lessee, and no favorable consideration has been given to applicants for Simeonof Island, as it is already occupied by natives and others.

Reports received from the lessees of the eight other islands indicate that nearly all are meeting with varying degrees of success. Blue foxes continue to be the chief animals farmed on practically all islands, although a few fur farmers experimenting with black foxes apparently are meeting with success, and a few small attempts are being made to farm martens. Fur farming in Alaska is still mainly confined to the southern and southeastern coast and adjacent islands.

For the purpose of securing definite information regarding the condition of the fur-farming industry with a view to helping build it up, the chief fur warden, accompanied by the bureau's fox-farming expert, has been making a reconnaissance along the southern coast with the power boat *Sea Otter*, gathering information to serve as the basis for a publication on fur farming in the Territory. Through cooperation with the Forest Service, which issues permits for fur farming on islands within the Tongass and Chugach National Forests, arrangements are being made for meetings of fur farmers in the Territory during the fall of 1922 for the purpose of conference and organization.

Fox farming is increasing in the Aleutian Chain, where permits for the use of suitable islands are still being issued free to natives and at a nominal charge to others. Seventeen permits were issued for islands in this chain during the year, making a total of 56 now in effect. Several permits for islands were canceled on recommendation of the bureau's representative at Unalaska, some permittees having died and others having failed to make use of their permits or having attempted to transfer them without approval. The natives are encouraged to use all suitable islands for the propagation of foxes.

A bill now pending in Congress, if enacted, will authorize the Secretary of Agriculture to lease all islands or other unoccupied Government lands lying outside of Government reservations in Alaska or issue permits for grazing or fur farming on them. Fur farming in the Territory is already becoming an important industry and can be made still more profitable by suitable legislation for the protection of those engaged in it.

The experiment of propagating martens in the Territory has not yet met with much success. Only one of the nine individuals holding permits reports progress. Several have discontinued their attempts, and it is probable that the successful propagation of these animals will be slow in developing. Discovery of the mating season of martens at the experimental fur farm in New York should be helpful in this connection.

## THE ALASKAN REINDEER INDUSTRY.

Satisfactory progress is being made in the reindeer work begun by the bureau in July, 1920. As a result of the investigations already made by the scientific staff stationed at Unalakleet (where the experiment station was first located), the manuscript for a department bulletin on "Reindeer in Alaska," fully illustrated and containing information on practically every phase of the reindeer industry, was prepared during the year. This will be the first report of its kind ever published and should be of much practical use to those now in the reindeer business, as well as to those contemplating engaging in it.

The coming year should show still greater progress and development of practical results from the reindeer investigations. Experiments along the lines of feeding and handling will be conducted to learn the practicability of using reindeer as draft animals through the use of a more substantial diet than reindeer moss and other native forage, which they now must seek after a day of hard work.

### GRAZING ALLOTMENTS.

The urgent need for expert study of the Alaskan reindeer and their herd management, to encourage the development of the business of raising these animals as a successful industry, is fully appreciated by the white herd owners, and they are showing keen interest in the work being done by the Biological Survey. Only about one-third of the reindeer are owned by whites, and the remainder mainly by the Eskimos. Now that the preliminary study of diseases and parasites and their control is completed, the working out of grazing-allotment areas is of immediate importance, and this is being done by three grazing experts with the use of an auxiliary power schooner belonging to the bureau. Among other investigations bureau experts are making quadrat studies of forage production and of the renewal of reindeer moss under varying conditions up to seriously overgrazed areas. A bill authorizing the Secretary of Agriculture to issue grazing permits has been introduced in the Senate, and the authority it contains is vitally needed for the development of the reindeer industry in the Territory.

### HERD MANAGEMENT.

Demonstrations of improved methods of handling herds and individual animals have been given at various places, and in a number of instances these have been followed by the herd owners with acknowledged benefit. Such practical field demonstrations will be needed over a great area in order to impress the minds of both Eskimo and white owners. The industry is new, and crude methods of herd management are still almost universal.

### REINDEER FROM NORWAY.

In March 60 reindeer arrived at the Government quarantine station at Athenia, N. J.—40 females and 20 males—which the Department of Conservation of Michigan had imported from Norway to be turned loose in the northern part of the Lower Peninsula of Michigan. An inspection of these animals by the bureau's chief reindeer expert from Alaska disclosed the fact that the Norway reindeer were much smaller than the average Alaskan animal, and also that their color was much paler. The experiment of the Michigan authorities will be watched with interest, because of the differing character of the snowfall and forage in the new habitat, particularly in view of the relative scarcity of the lichens and other food similar to that on which the animals were accustomed to feed.

In order to obtain more information regarding methods of reindeer management, Dr. Seymour Hadwen, who was the chief reindeer specialist for two years in Alaska, will go to northern Europe during the summer of 1922 to study the industry there, including herd management, prevalent parasites and diseases and their control, and such other matters as will be helpful to the bureau and to herd owners in Alaska.

### LARGE CARIBOU BULLS FOR BREEDING PURPOSES.

A field naturalist with headquarters at Fairbanks has continued investigations of the caribou of that region, and much valuable information has resulted. A supply of the large type of caribou from which young bulls may be obtained for use in breeding experiments to increase the size and vitality of the reindeer has been located in the Mount McKinley National Park. With the cooperation of the National Park Service arrangements are being made to capture some of these animals and hold them in an inclosure in the park until they can be taken down the Yukon on a barge and placed with a herd of reindeer from which the reindeer bucks will be eliminated. It is believed that the meat output of the Alaskan reindeer can be practically doubled by careful selection of breeding stock.

## GAME AND BIRD RESERVATIONS.

Federal game and bird reservations now number 69, all but one of which are bird refuges, and this one is also a national park, so that birds are protected there under park regulations. Five of the number are big-game refuges.

The plan of temporarily transferring wardens from one reservation to another in order to broaden their experience and usefulness has been successful. It is now contemplated filling the assistant warden vacancies as they occur with young men of proper fitness to develop into wardens, thus enabling them to grow up in the service. The practice of transferring these assistants to different reservations and of detailing them for a short time to the central office at Washington will fit them for a more effective performance of their duties and provide a well-trained personnel competent to develop the reservations along the lines of greatest usefulness.

Owing to a general need for information in reference to existing State and Federal game and bird refuges in the United States, a list of each group was prepared and issued in mimeographed form. Because of insufficient information, the lists are not absolutely complete as to the number of refuges and their acreage, but revised editions will be issued as additional data are received.

Of the 423 State game and bird refuges listed, 346 contain a total of 19,331,593 acres. Wyoming has the greatest acreage of State game and bird refuges, 4,201,200 acres in 13 units; Minnesota comes next with 2,750,936 acres in 64 units; California has 1,792,000 acres in 28 units; and Montana 1,503,429 acres in 12 units.

The list of Federal game and bird refuges gives a total of 115. The 84 for which the acreage is given have a total of 10,323,904 acres.

The great area included in Federal and State game and bird refuges indicates how general is the interest in the protection of game and birds. These refuges are scattered throughout the country and in Alaska, Porto Rico, and the Hawaiian Islands, and few States are without them. The States lacking refuges of this kind are Mississippi, Nevada, New Hampshire, South Carolina, and West Virginia.

### BIG-GAME PRESERVES.

Most of the big-game animals have increased, but serious losses were suffered in the antelope herds on the Montana Bison Range and the Wind Cave Game Preserve, S. Dak., and in the elk in Jackson Hole, Wyo. The year was marked by appalling losses of antelope, and it will take years of painstaking effort to bring these herds back to their former numbers. On the Bison Range the antelope were killed mainly by coyotes, which ran them into deep snowdrifts, where they became practically helpless. At Wind Cave large bobcats appeared to be the chief offenders, trailing the antelope in the snow and apparently killing full-grown bucks without difficulty.

This experience with predatory animals at the Bison Range and Wind Cave, combined with the severe weather conditions, indicates forcibly the difficulty attendant on developing antelope herds under fence. Their former freedom to range widely was a strong element in their favor. Under fence they appear to be the most helpless of our large game. As game preserves are developed they will naturally attract predatory animals from a wide adjacent region, especially during severe seasons when food becomes scarce. Unsatisfactory conditions caused by the drifting snows which fill the gullies and depressions raise the question of whether locations like the Wind Cave Preserve and the National Bison Range are well suited to building up antelope herds. Areas subject to a lighter snowfall, even though the same temperatures and high winds prevail, may prove better suited to these animals. A milder climate or lighter snowfall may be needed to insure success. Efforts are being continued to establish a large antelope range in the southwestern part of Idaho.

The following table shows the number of big-game animals under fence on the preserves at the close of each calendar year from 1916 to 1921; the figures for 1922 are as reported on June 30, and, except for the buffalo, are approximations:

| Kind of game. | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|
| Buffalo | 206 | 251 | 311 | 381 | 431 | 508 | 594 |
| Elk | 165 | 205 | 261 | 345 | 433 | 519 | 578 |
| Antelope | 47 | 57 | 55 | 54 | 65 | 91 | 45 |
| Deer, mule | 2 | 2 | 15 | 21 | 27 | 54 | 52 |
| Deer, white-tailed | 3 | 6 | 8 | 9 | 5 | 21 | 31 |
| Mountain sheep | | | | | | | 16 |
| Total | 423 | 521 | 650 | 810 | 961 | 1,193 | 1,316 |

Two educational motion-picture films have been prepared during the year to illustrate the work of this division. One, entitled "Anne's aigrette," showing interesting pictures of the American egrets, snowy herons, and other birds on the Walker Lake Bird Reservation, Ark., is designed to demonstrate the inhumanity of the traffic in the plumage of these birds for the purpose of personal adornment. The other film shows views of the birds on the bird-refuge islands near the mouth of the Mississippi in the Gulf of Mexico and is entitled "National bird refuges."

Detailed histories of the Bison Range and Wind Cave Preserve have been completed, a rough draft of a history of the Niobrara Reservation, Nebr., has been made, and data assembled for the writing of histories of other refuges.

*National Bison Range, Mont.*—With the exception of the deplorable loss of antelope during the past winter, the animals and birds have done well on this preserve, although in spring the animals were much reduced in flesh, owing to the exceptionally severe winter. Eight buffalo died during the year and 77 were born, increasing the number to 452. All deaths in the herd within the past year have apparently been from natural causes, as there has been no contagious sickness of any kind. The elk now number 325 as against 265 last year.

The unfortunate loss of antelope reduced the herd from 60 (the number reported on June 30, 1921) to 17. During the time when the range was covered with snow coyotes drove the antelope into drifts, from which they could not escape, and killed by far the larger part of the herd, an unprecedented loss. On June 30, 1922, it was estimated that 25 antelope were on the range, counting a few young of the year. Since January 1, 30 coyotes have been trapped, shot, or poisoned on this preserve or near its boundary, and 76 others were taken in the surrounding country.

In the autumn of 1921, 17 white-tailed deer and 17 mule deer were received at the range, the gift of Frank Conley, of Deer Lodge, Mont. The estimated number of mule deer now on the range is 50; and of white-tailed deer, 25.

Through the courtesy of the Canadian National Parks Service, 12 mountain sheep were obtained in February from Banff, Alberta. The band consisted of four rams and eight ewes, which were kept in a corral near the warden's quarters on the range during the remainder of the winter. They are doing well and have increased in number to 16.

The 24 ring-necked pheasants turned out in the fiscal year 1921 had increased to about 124, and at the present time 100 are reported on the range. The introduction of the pheasants has been so successful that the State has contributed this year nine pairs of European partridges, and it will be interesting to note the result; they now number 25.

Two reservoirs for watering places for the animals have been completed, one on the west side of the range and the other near the southeast corner.

*Wind Cave National Game Preserve, S. Dak.*—This year's calf crop has increased the buffalo herd from 71 to 90, and the elk number 149, not including calves. During the exceptionally severe weather conditions last winter the antelope herd was reduced by bobcats and coyotes from 34 to 14. The remaining animals are in splendid condition, and on June 30 there were 6 fawns reported, making a total of 20 antelope in that herd. Since January 1, 75 predatory animals were caught on Wind Cave Preserve and in the surrounding country.

A light motor truck has been obtained for use at this preserve and is a valuable addition to the equipment, as it will be very useful for fire fighting and for facilitating fence repairs, road work, and other necessary activities.

Concrete work at one of the watering places for the animals was completed during the fiscal year and has made it possible for the spring to be used more extensively and at all seasons.

*Niobrara Reservation, Nebr.*—There are now 41 buffalo, 54 elk, and 1 deer, as against 37 buffalo, 53 elk, and 1 deer a year ago. It is hoped that new blood can be introduced into the elk herd next year. The inspector has been instructed to arrange for the transfer of some of the excess elk from Sullys Hill to Niobrara and at the same time to weed out some of the older or less desirable animals now on this reservation.

The new game fence, 12 miles in length, is still under construction. Posts are set and a contract has been let for erecting the wire for a distance of 822 rods. When this fence is finished it will inclose approximately 4,320 acres, making this one of our best game refuges.

*Sullys Hill National Game Preserve, N. Dak.*—The buffalo have increased from 9 to 11, the elk from 36 to 50, and the deer from 3 to 5 during the year.

Construction work on the hostess house and other buildings and improvements was advanced last summer, and it is hoped that the work will be entirely completed during the coming summer.

*Elk Refuge, Wyo.*—The winter of 1921–22 is reported to have been the severest on record in relation to the elk. Extreme weather conditions did not commence until after the 1st of January. Heavy thaws followed early snows, and the resulting slush was later frozen into solid ice over the grazing lands, making it impossible for the elk to get at the native forage.

The bureau had on hand at the commencement of the winter slightly more than 1,000 tons of hay, a larger supply than ever before. In addition to this, the State furnished 200 tons. This 1,200 tons was exhausted in April, before spring conditions permitted the elk again to do their own foraging, and no funds were available to purchase more. As a result approximately 20 per cent of the total number of the elk that came to the refuge perished, not so many as in the winter of 1919–20 but probably a larger percentage of those that came to the refuge. The greatest number of elk reported on the reservation at any one time during the winter was 4,350.

There is no hay now on hand, but the outlook is good for a better crop than that of last year, which amounted to 644 tons. While it is unlikely that another extreme winter will follow that just past, still it is deemed unsafe to start the winter with so small a stock on hand, and additional hay will be purchased.

### BIRD REFUGES.

There are now 68 Federal bird refuges, 4 of which are located on the big-game preserves. No new reservations have been added during the year, and one has been abandoned—the Yukon Delta Reservation, Alaska, eliminated by Executive Order No. 3642, issued February 27, 1922. The North Platte Reservation, Nebr., was slightly reduced in area by Executive Order No. 3540, dated August 26, 1921.

Twenty-seven of these reservations have warden service; of the wardens employed 9 are permanent to safeguard the reservations, 11 are part-time, and 10 are cooperative. Individual reports on all the bird refuges are not deemed necessary, but notes are given on several of the more important ones.

*Big Lake, Ark.*—Conditions at this reservation have continued to improve during the past year, and violations of the game laws and also of State fishing laws are less frequent. Working in cooperation with State officials, it has been very difficult for reservation wardens in the past to identify illegal fishing tackle frequently found. Recent departmental regulations requiring that all set tackle should be tagged have worked out very satisfactorily. As it is now, a man would naturally hesitate to put his identification tag on an illegal net, and untagged nets are subject to confiscation.

A survey of the boundary line has been made and the line fairly well cut and blazed, and galvanized wire is being run along its entire length. Runways have been cut through the woods, so that the wardens may quickly reach different points on the reservation and also obtain a view of places formerly hidden by brush and limbs.

During the autumn of 1921 the greatest flight of mallards since before 1918 was reported, and more Canada geese going south over Big Lake than usual, many of them stopping to feed and rest. There was also a larger number of wood ducks in the reservation and vicinity than for many years.

*Lake Malheur, Oreg.*—In January representatives of the Biological Survey met the governor, attorney general, State engineer, and other representatives of Oregon in Salem for the purpose of considering a compromise by which the controversy over the status of this reservation might be settled. The conference was very satisfactory, and there is a strong probability that this long-drawn controversy may be amicably concluded to the advantage of all concerned. To secure needed information representatives of the bureau and of the State visited the reservation in June, and a definite plan of action will be proposed in the near future. Because of unprecedented winter weather conditions at this reservation, it became necessary for the warden to feed grain to the birds, as they were threatened with starvation.

*Tortugas Keys, Fla.*—Through the courtesy of the Navy Department the warden's house on this reservation, which was completely undermined by the cutting away of the shore and in danger of falling into the sea, has been moved to the opposite or eastern side of the key and substantially set up on new piling. The key is developing considerable vegetation, which is of much importance to certain nesting birds.

*Belle Fourche, S. Dak.*—The effect of continuous grazing over the lands immediately adjoining the lake shore has raised the question as to whether the lack of nesting birds is not due to this destruction of growth which might form shelter for them. To settle this question definitely it has been planned to fence off a portion of the area known as the peninsula, and the fence has been partly constructed. This will be completed as soon as possible, and with the cooperation of the Reclamation Service the live stock eliminated from the area.

*North Platte, Nebr.*—The two smaller of the four reservoirs (No. 2 and Winter Creek) composing this reservation are very promising places for wild fowl. Unfortunately, the ponds are small, but as the rise and fall of the water does not vary more than about 2 feet they should lend themselves admirably to the planting of wild duck foods. At one of these ponds tules and some small willows and cottonwoods are already in evidence along a part of one side. The surroundings of both reservoirs are marshy.

*Mosquito Inlet, Fla.*—A petition has been received from the residents in the vicinity of Holly Hill, Fla., for the extension of this reservation. This shows very clearly a gratifying change of sentiment on the part of local residents toward bird protection, as at the time the refuge was created local opposition was voiced against the inclusion of any additional area.

*Tampa Bay Group, Fla. (Passage Key, Indian Key, and Palma Sola).*—Bush Key, which was included in the enlargement of the Indian Key Reservation, is reported to have its usual colony of roseate spoonbills, 143 having been counted by the inspector in June and a considerably greater number being reported to occur there. Passage Key was seriously damaged by a hurricane in October, and was reported to have been entirely washed away. Either this report was not strictly correct or else the sand rapidly built up again, for in January, 1922, a considerable part remained above water. The mangroves, however, had been washed away in June, 1922, and the inspector found only a small bit of the key above water, and that appeared to be washing away from the north side. It was covered with pelicans, gulls, terns, and skimmers, but no birds were nesting.

*Carlsbad and Rio Grande, N. Mex., and Salt River, Ariz.*, are all reclamation projects, and while practically no ducks nest on them, they serve during migration and in winter as resting places for wild fowl which would otherwise be forced to go beyond the border. Many blue herons and cormorants nest on the Salt River Reservation.

## MIGRATORY-BIRD TREATY AND LACEY ACTS.

The administration of the migratory-bird treaty and Lacey Acts has been seriously embarrassed by insufficient funds for maintaining an adequate warden service. Violations of the law will continue to increase until wardens can be maintained in every State. As against this disquieting situation, it is very encouraging to have reports from practically every section of the United States showing that the protection now given migratory birds is resulting in a material increase in their numbers. It has been most gratifying to observe, since the abolition of spring shooting, that waterfowl in ever-increasing numbers are extending their breeding range, convincing proof of the wisdom of the advocates of Federal protection for migratory birds.

Waterfowl have, in fact, increased to such an extent that the matter of maintaining adequate breeding, resting, and feeding places is becoming a serious problem. Reliable information is at hand from Oregon that large numbers of wild ducks died of starvation and others were in an emaciated condition after having eaten all the vegetation from the ponds in the locality in which they were found. This emphasizes the necessity for prompt and vigorous action in setting aside and perpetuating as homes for the birds and other wild life marsh and water areas unsuitable for agriculture, or less valuable for agricultural uses than they are in their natural state.

### EARLY MATING OF MIGRATORY WILD FOWL IN MISSOURI.

Early in February, 1922, the bureau assigned an assistant biologist to investigate mating and breeding habits of wild fowl in Missouri, where it has been contended by a few persons, still persisting in their demands for spring shooting, that wild ducks are not mated before March 10 and do not breed in the State. Data gathered by this biologist, as previously mentioned, furnish incontrovertible proof justifying the attitude of the bureau in opposing the granting of any wildfowl shooting privileges later in winter than January 31.

### COOPERATION.

Cordial cooperation extended by State game officials and sportsmen from practically every State has contributed in a large measure toward the results achieved, not only in the enforcement of the law but in creating favorable public opinion toward its observance. Without this cooperation the bureau, with its slender force of wardens, would have been desperately handicapped.

### WARDEN SERVICE.

During the year the number of United States game wardens varied from 25 to 28. They were aided by 48 United States deputy game wardens, receiving a salary when employed during short intervals in emergencies, and by approximately 350 United States deputy game wardens stationed at suitable points throughout the country, who receive a nominal salary of $1 per annum and cooperate by reporting violations, thus bringing about better observance of the law.

Violations have been numerous and appear to have increased in large sections of the country where there are no Federal wardens. It became necessary in many instances to transfer wardens from remote sections for temporary duty to localities where especially flagrant outbreaks of violations were occurring. These special assignments were salutary, but to get effective results it has been found essential to have regular employees at all times in important wildfowl sections.

Data gathered by the bureau show that over 4,000,000 State hunting licenses were issued during the year, but this does not represent the total number of hunters, since in many States farmers and others in certain instances are exempted from the operation of hunting-license laws. With the entire United States to patrol and with such a large number of hunters in the field, it is evident that the services of a substantial force of game wardens are required if the law is to be effectively enforced and desired results are to be achieved.

### MIGRATORY-BIRD TREATY-ACT ADVISORY BOARD.

The annual meeting of the Migratory-Bird Treaty-Act Advisory Board was held in Washington on December 15, with nearly all members present. Certain amendments of the Federal regulations suggested by the bureau and concurred in by the board were adopted by the Secretary and became effective on March 8, 1922, upon approval by the President. These amendments were as follows: The open season for waterfowl in New Mexico was changed from the period October 16 to January 31 to the period October 1 to January 15; the open season for mourning doves in Mississippi and Louisiana was changed from the period October 16 to January 31 to the period September 16 to December 31; and the season for mourning doves in North Carolina and South Carolina was changed from October 16 to January 31 to extend from September 1 to December 15.

### VIOLATIONS OF THE MIGRATORY-BIRD TREATY ACT.

On July 1 there were 772 migratory-bird treaty-act cases pending. Of these, 194 were disposed of during the year by convictions, 60 were nolle prossed, in 36 grand juries did not return true bills, 54 were dismissed, and 2 were terminated by death of the accused. Fourteen cases tried before a jury resulted in verdicts of not guilty and 412 cases are still pending. During the fiscal year 742 new cases were reported for prosecution; of these, 349 convictions have been obtained to date, 39 have been nolle prossed, in 4 grand juries did not return true bills, 35 were dismissed, and in 5 the jury returned a verdict of not guilty. Fines and costs collected amounted to slightly over $9,800 and ranged from $1 to $250 each, and many of the defendants were also required to pay the costs, which in many instances equaled, and in others exceeded, the amount of the fine. About 200 other cases were reported by Federal wardens which for various reasons were not forwarded for Federal prosecution, but the evidence in many of them was transmitted to State game authorities for appropriate action, as infractions of State laws were involved.

The convictions in Federal courts were distributed as follows: Alabama, 27; Arkansas, 35; California, 2; Connecticut, 2; Delaware, 3; Florida, 11; Georgia, 59; Idaho, 5; Illinois, 38; Indiana, 11; Iowa, 9; Kansas, 6; Kentucky, 7; Louisiana, 7; Maine, 6; Maryland, 28; Massachusetts, 29; Michigan, 4; Minnesota, 12; Mississippi, 13; Missouri, 20; Montana, 2; Nebraska, 8; New Hampshire, 1; New Jersey, 13; New Mexico, 1; New York, 3; North Carolina, 4; Ohio, 7; Oklahoma, 1; Oregon, 8; Pennsylvania, 6; Rhode Island, 3; South Carolina, 1; South Dakota, 8; Tennessee, 54; Texas, 38; Virginia, 23; Washington, 18; Wisconsin, 10.

Many substantial penalties were imposed against violators, although some offenders escaped with small fines or merely on the payment of costs. Among the penalties imposed were 10 jail sentences ranging from 5 days to 4 months, in Arkansas, Florida, Illinois, Maryland, South Carolina, and Virginia, and fines ranging as high as $250; and a number of the violators were given both fines and jail sentences. The character of violations included trapping and selling wild ducks, illegal shipment of ducks for sale, killing wild ducks in close season, killing great blue herons, hunting ducks after sunset, hunting waterfowl from a sailboat, and offering to sell wild ducks. Many other fines ranging from $25 to $100 were also imposed against offenders for offering to sell and selling aigrettes, possessing ducks in storage during the close season, and for other miscellaneous offenses. The third conviction for the hunting of wild fowl from an airplane was obtained in the Federal court at Trenton, N. J., on February 12, where the violator charged with killing a goose from an airplane was fined $25.

An extended drive against persons killing mourning doves during the close season was made in several of the Southern States and resulted in the apprehension of 160 violators. Of this number 118 have been prosecuted and fines ranging from $5 to $20 imposed, as follows: Alabama, 17; Georgia, 49; Mississippi, 20; and Tennessee, 32. The remaining cases are still pending.

The mourning, Carolina, or turtle dove, is a migratory bird coming within the protection afforded by the migratory-bird treaty and the act of Congress to give it effect, even though individuals of the species remain within the borders of certain States the entire year, according to a decision rendered in the case of United States against Joseph H. Lumpkin, brought to trial at Athens, Ga., November 14, 1921, before Federal Judge S. H. Sibley and a jury. The defendant, who was charged with killing mourning doves during the Federal close season, contended that the birds which he had killed had not migrated, but had remained in Georgia the entire year, and for this reason were not covered by the Federal statute. The court held as a matter of law that the mourning dove is protected by the migratory bird treaty act and regulations and instructed the jury that the only question of fact to be decided by it was whether the defendant actually killed mourning doves in the close season as charged in the indictment. The trial, which consumed two days and attracted widespread attention, resulted in a verdict of guilty and the imposition of a fine of $25 and costs.

A large number of seizures were made of migratory game birds illegally killed or possessed, and most of these were disposed of by the bureau, with consent of the accused, by gift to hospitals or charitable institutions for use as food. Contraband plumes and mounted specimens of migratory birds of an estimated value of $2,000 were seized during the year. Many of these specimens were formally released to the bureau to be used for scientific and educational purposes.

Many violations of State game laws were observed during the year by Federal wardens, who transmitted the evidence in regard thereto to proper State game officials for prosecution, and information received to date shows that 94 such cases have been successfully prosecuted, netting fines totaling $3,436.

The wardens also conducted an educational campaign to enlighten the public concerning the provisions of the Federal game laws and their objects and purposes. In three instances wardens were assaulted by violators while attempting to perform their duties, and in one case the warden was overpowered by three violators and relieved of his pistol and badge.

## PERMITS.

During the year, 952 permits were issued authorizing the collecting of migratory birds, nests, and eggs for scientific purposes. More than half of these were limited permits, confining operations to the collection of nongame birds and of shorebirds during the open season for black-breasted and golden plovers and greater and lesser yellowlegs. The issuance of these limited permits was authorized by an amendment of regulation 9 of the migratory-bird treaty act regulations adopted March 3, 1921. Reports from the permittees show that approximately one-third of them collected no birds, nests, or eggs whatsoever during the year. A large number of others collected less than five birds each and no nests or eggs. Permits authorizing the possession, purchase, sale, and transportation, but not the collection, of migratory birds lawfully taken for scientific purposes were issued to 185 persons; permits of this nature are issued usually to taxidermists or others to whom it appears undesirable to give the privilege of collecting specimens.

Permits authorizing the possession and sale of migratory waterfowl raised in captivity were issued to 4,765 persons, and permits authorizing the taking of a limited number of waterfowl or their eggs for propagating purposes were issued to 87.

In its quest for information relative to the times and lines of flight of migratory birds, the bureau issued permits authorizing the trapping of migratory birds alive for banding purposes to 490 persons. The holder of a bird-banding permit is allowed to possess a migratory bird only a sufficient length of time for it to be properly banded and liberated.

### INTERSTATE COMMERCE IN GAME.

Ten new cases involving violations of the Lacey Act were reported to the Solicitor for prosecution during the year. This reduction in the number of cases from that of previous years is no doubt occasioned by the fact that shipments of birds, which were formerly covered by the Lacey Act, now come under the migratory-bird treaty act. Thirty-two cases were disposed of in court, 4 of which were dismissed and 1 nolle prossed; the total fines collected in the remaining 27 cases amounted to $931.10. One hundred and fifteen investigations were closed for various reasons, a sufficient amount of evidence not being secured to warrant prosecution, the shipments being found to be legal, the offense having occurred so long ago that it had expired under the statute of limitations, or the nature of the offense not warranting prosecution. Two hundred and twenty-two cases were turned over to State officials for prosecution under State laws, 118 of which have already resulted in convictions netting the States a total in fines and costs of approximately $5,000. At the present time investigations are pending in the bureau in approximately 150 cases. The enforcement of the Lacey Act has been particularly effective in suppressing traffic in beaver skins illegally taken.

### IMPORTATION OF FOREIGN BIRDS AND MAMMALS.

Following the war period of depression, the importation of birds and mammals from foreign countries is gradually returning to normal. Although the 528 permits issued were 32 less than in 1921, the number of individuals and species was greater and the number of shipments inspected increased from 155 to 186.

Canaries were imported in increased numbers, and the trade in parrots with Mexico, South America, and Australia is being revived. Traffic in game birds is increasing more slowly and is confined chiefly to Mexican quail and Hungarian partridges. At Honolulu, Hawaii, additional permits were issued for the entry of miscellaneous birds, chiefly pigeons, quail, and ducks. Altogether there were entered under permit 154,547 canaries, 37,953 Mexican quail, and various other miscellaneous birds, making a total of 313,623, of which 274,997 were inspected. In addition, there were entered at the ports of New

York, San Francisco, and other ports, chiefly as passengers' baggage without requirement of permit, 9,075 parrots and parrakeets, 4,627 canaries, and 10,352 miscellaneous birds. These latter included many parrots brought in at the ports of Brownsville and Laredo, Tex., without permits when not accompanied by other birds. The total number of birds imported during the year was 337,677.

Permits for mammals included 2,064 foxes from Canada. A considerable number of these permits were not used and others covered the entry of animals brought in for exhibition purposes and later returned. The number of foxes actually remaining in the country, therefore, was probably less than that stated. During the year many foxes were admitted to entry without quarantine under inspection by official veterinarians of the Canadian Government. In view of the examination of the animals by Canadian authorities prior to shipment, the requirements of quarantine at the border seemed unnecessary, and this regulation was rescinded on October 15.

The year has been notable for the number of elephants brought in for menageries and zoological gardens. Among other noteworthy mammals was a duckbill (*Ornithorhynchus anatinus*) from Australia, the first ever brought alive to the United States. This interesting animal reached San Francisco late in June and was exhibited in the New York Zoological Park for about two months previous to its death, the last of August, 1922. Shipments from Australia also included several species of kangaroos and other marsupials, rarely, if ever, imported before, such as the Parry wallaby (*Osphranter parryi*), the striped wallaby (*Petrogale lateralis*), and the vulpine phalanger (*Phalangista vulpina*).

The importation of birds for cage-bird traffic, restocking game covers, and exhibition in zoological parks has shown a marked increase. The number of canaries imported last winter for the Christmas trade, though smaller than in years prior to the war, was more nearly normal than for some seasons past. Traffic in parrots has also shown some development. A few large shipments of Cuban parrots have been received at New York, and several extensive shipments of parrots and parrakeets have been made from Australia. In one instance no less than 6,000 Australian love birds, or shell parrakeets (*Melopsittacus undulatus*), were received in a single consignment. Game birds for restocking covers have been confined chiefly to Mexican quail and Hungarian partridges. The importation of the latter species has been resumed for the first time since 1915, and two large shipments were received in the spring, one of which included 1,000 birds for the State of Montana. The Hungarian partridge has done well in the Northwest, particularly in eastern Washington, northeastern Oregon, and the Province of Alberta. The success which has attended experiments in introducing this species in that region has led to many inquiries and a renewed interest in the importation and distribution of the birds.

Pheasants have shown no appreciable return to normal so far as entries are concerned. Since the war most of the traffic in pheasants for propagation has been confined to those raised in the United States, either on State or on private game farms, and the large number formerly imported from England and Canada has diminished to small proportions. The importation of birds for exhibition purposes from Europe and Australia has shown an unusual variety, and many rare species not often brought in have been received during the year. On the other hand, a few birds formerly common, as the rhea, or South American ostrich, have fallen off to such an extent that an entry is a noteworthy event, only two or three shipments containing rheas being received during the year.

An unusual number of interesting birds arrived from South America and from Australia and the neighboring islands. Among these may be mentioned 9 pileated herons (*Pilherodius pileatus*) from Colombia, a black guan (*Aburria aburri*) from Venezuela, a Cassin macaw (*Ara auricollis*) and a Weddell parrakeet (*Eupsittula weddelli*) from Bolivia, a number of kagus (*Rhinochetus jubatus*) from New Caledonia, 25 Philippine pectoral rails (*Hypotaenidia philippinensis*), 55 New Guinea pink-headed pigeons (*Ptilopus superbus*), a Ducorps cockatoo (*Cacatua ducorpsi*) from the Solomon Islands, and a number of Australian species, as the semipalmated goose (*Anseranas semipalmata*), the regent bower bird (*Sericulus melinus*), the Morton Bay rosella parrot (*Platycercus pallidiceps*), the Bourke parrakeet (*Neophema bourkei*), the gold and green lory (*Psitteuteles chlorolepidotus*), the Princess Alexandra parrakeet (*Polytelis alexandrae*), and a large number of other parrots, cockatoos, and love birds.

## IMPORTATIONS OF QUAIL FROM MEXICO.

Through the cooperation of the Bureau of Animal Industry inspection of quail from Mexico was provided, as heretofore, at Brownsville, Laredo, and Eagle Pass, Tex., from November 1 to April 20. Quarantine of birds, however, was not required if the shipments showed no evidence of quail disease. Few birds arrived until the latter part of January. The total number of quail entered during the season was 37,953, the largest number ever entered in any one year. At Brownsville 9,773 birds were entered; at Laredo, 15,408; and at Eagle Pass, 12,772. Quail disease appeared at Laredo about February 23, and 500 birds were placed in quarantine, but with this exception few losses due to the disease occurred. On the whole the season was one of the most successful in recent years. Most of the quail imported were shipped to the State game authorities of Kentucky, Maryland, and Pennsylvania and were distributed for propagating purposes; Kentucky received 6,600 and Maryland 10,317. The Maryland consignments, comprising nearly a third of the total number imported, suffered a loss of less than 1 per cent through deaths en route.

The number of quail received from Mexico during the 12 years since importation began has now reached a total of 152,348. Many of the birds this season were sold at prices ranging from $18 to $24 or more a dozen, which would make the cost to purchasers of the importations this year between $55,000 and $75,000.

## PUBLICATION AND INFORMATIONAL WORK.

During the year 24 publications of the department prepared in the Biological Survey were issued, including 5 revisions of earlier bulletins; and at the close of the year 11 manuscripts, including 3 revisions, were in press or had been submitted to the Assistant Secretary for publication, and 4 new manuscripts prepared during the year, including 1 revision, were ready for editing preliminary to publication.

Publications issued during the year were as follows: Annual Report of Chief of Bureau for 1921; Department Bulletin No. 1049, Game as a National Resource; North American Fauna No. 45, A Biological Survey of Alabama: Part I, Physiography and Life Zones; Part II, The Mammals; Farmers' Bulletins No. 1235, Game Laws for 1921; No. 1238, Laws Relating to Fur-Bearing Animals, 1921; No. 1239, Community Bird Refuges (including one revised edition); and No. 1247, American Moles as Agricultural Pests and as Fur Producers; Department Circulars No. 196, Directory of Officials and Organizations Concerned with the Protection of Birds and Game, 1921; and No. 225, Annual Report of the Governor of Alaska on the Alaska Game Law, 1921; Separates from the 1920 Yearbook: No. 836, Conserving Our Wild Animals and Birds; No. 843, Farm Help from the Birds; No. 845, Hunting Down the Stock Killers; and No. 855, Death to the Rodents; Service and Regulatory Announcements Nos. 42 to 46 (B. S.), containing the text of regulations and orders affecting bird reservations and land fur-bearing animals in Alaska; Poster No. 41 (Bi.), Open Seasons for Game, 1922; and revisions of the following: Department Bulletin No. 793, Lead Poisoning in Waterfowl; and Farmers' Bulletins No. 525, Raising Guinea Pigs; No. 621, How to Attract Birds in the Northeastern United States; No. 912, How to Attract Birds in the East Central States; and No. 1239, Community Bird Refuges, above mentioned.

Manuscripts in press or submitted to the Assistant Secretary and not published at the close of the year were as follows: Department bulletins No. 1078, Beaver Habits, Beaver Control, and Possibilities in Beaver Farming; No. 1089, Reindeer in Alaska; and No. 1091, Life History of the Kangaroo Rat, *Dipodomys spectabilis spectabilis* Merriam; North American Fauna, No. 46, A Biological Survey of Alabama: Part III, The Birds; No. 47, A Biological Survey of North Dakota: Part I, Physiography and Life Zones, Part II, The Mammals; No. 48, A Biological Survey of the Pribilof Islands, Alaska: Part I, Birds and Mammals, Part II, Insects, Arachnids, and Chilopods; No. 49, Mammals of New Mexico; Farmers' Bulletin No. 1288, Game Laws for 1922; and revisions of the following farmers' bulletins: No. 506, Food of Some Well-known Birds of Forest, Farm, and Garden; No. 702, Cottontail Rabbits in Relation to Trees and Farm Crops; and No. 844, How to Attract Birds in the Middle Atlantic States.

Manuscripts completed during the year but not yet submitted for publication were as follows: A department bulletin on "The marsh and aquatic plants of Missouri as wild-duck foods"; a department circular on "Experiments in the use of carbon tetrachlorid as an anthelmintic for foxes"; a farmers' bulletin on "How to get rid of rats"; and a revised farmers' bulletin (No. 770) on "Canaries: Their care and management."

In addition, many items for the press and articles for outside scientific periodicals have been prepared or authorized, and numerous photographs have been selected from official negatives for the press and for individual writers.

# REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

United States Department of Agriculture,
Division of Accounts and Disbursements,
*Washington, D. C., October 11, 1922.*

Sir: I am transmitting herewith the annual report of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1922.

Very respectfully,

A. Zappone,
*Chief of Division.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

## CHARACTER OF THE WORK.

The Chief of the Division of Accounts and Disbursements, in accordance with law and regulation, pays accounts submitted by the various bureaus, divisions, and services of the department. Accounts are examined to ascertain that approvals are genuine, that extensions and additions are correct, and that there are appropriations out of which they are legally payable. A cashbook record is maintained of all individual payments, and ledger records are kept of disbursing and appropriation debits and credits of all funds of the department. Through the use of a card index duplicate payments are prevented and a ready reference to payments is available. The division also supervises the placing of funds to the official credit of temporary special disbursing agents and other fiscal officers of the department, and after making a record thereof transmits their accounts to the General Accounting Office. It receives and accounts for all moneys due the department from various sources; makes advances of public funds to employees for the payment of their expenses while traveling on official business; maintains a record of liabilities and disbursements in connection with purchases of lands under the Weeks forestry law; keeps the departmental record of amounts withheld from employees' salaries under the provisions of the retirement act of May 22, 1920, and, under the direction of the Secretary and the Budget officer, compiles the annual estimates of appropriations. Miscellaneous financial reports are prepared from time to time as required. During the fiscal year 1922 this office also received and deposited in the Treasury all the collections of farmers' seed grain loans, and maintained the file of notes and mortgages and a detailed record of the repayments thereunder.

## WORK OF THE YEAR.

### APPROPRIATIONS, EXPENDITURES, ETC.

To carry on the regular work of the Department of Agriculture, consisting of its investigative, regulatory, and other routine activities, and to administer the cooperative agricultural extension work, Federal highway and forest road and trail construction, and other special activities devolving upon the department by operation of law, during the fiscal year ended June 30, 1922, Congress appropriated or authorized for expenditure $135,046,918. This sum includes $36,404,259 carried in the agricultural appropriation act for that fiscal year; supplemental appropriations of $1,627,875 contained in various deficiency appropriation acts; the permanent annual appropriations of $3,000,000 for the enforcement of the meat inspection act, and $4,080,000 for extension work in agriculture and home economics in cooperation with the States; the appropriation of $1,500,000 provided by the special act for making seed grain loans to farmers in the drought-stricken areas of the Northwest; $75,000,000 for the construction of highways in cooperation with the States, and $6,000,000 for road and trail building within or adjacent to the national forests; $3,137,882 for payment of the increase of compensation to the employees of the department; $725,000 for printing and binding; $2,941,375 which became available from national-forest receipts and Forest Service cooperative funds for cooperative work, road and trail construction, refunds to depositors, and payments to the States for the benefit of roads and schools; and $630,527 in special appropriations and in allotments transferred from other departments under section 7, fortifications act of May 21, 1920, for work to be done at their request by the Department of Agriculture. In addition to these appropriations made for the fiscal year 1922, unexpended balances of appropriations made for prior years totaling $225,137,391 remained available for expenditure during this year. The largest portion of these unexpended balances consisted of $193,693,859 in Federal aid road-construction funds and $3,806,759 in forest road and trail building appropriations, available until expended and encumbered within $8,500,000 of their total through cooperative road building agreements with States, counties, and communities; $9,936,328 remaining from the war emergency revolving fund for the purchase and distribution of nitrate of soda, and $5,680,380 from the revolving fund for stimulating agriculture through the purchase and distribution of seeds during the war period, the bulk of both these revolving funds being finally transferred to the surplus fund of the Treasury in December, 1921. The remainder of the unexpended balances available for expenditure during the fiscal year 1922 consisted of $5,478,058 in balances under the various appropriations contained in the agricultural appropriation act for the fiscal year 1921 and $802,868 under other appropriations for that year; $3,736,680 in balances remaining from appropriations provided by the agricultural act for the fiscal year 1921, and $23,750 from other appropriations for that year; and $1,978,709 in unexpended balances of continuing appropriations from prior years remaining available until expended. The total amount available from all sources for expenditure during the fiscal year 1922 was therefore $360,184,309.

During the year the disbursements of the department amounted to $147,289,385, of which $31,000,029 was disbursed from the appropriations provided by the agricultural appropriation act for the fiscal year 1922, $16,670,878 from the permanent annual, supplemental, special, and indefinite appropriations and the allotments from other departments made for that year, and $99,618,478 from the unexpended balances of annual and continuing appropriations for prior fiscal years. On December 7, 1921, $9,500,000 of the unexpended balances remaining in the revolving fund for the purchase and distribution of nitrate of soda and $5,670,000 of the unexpended balance remaining in the revolving fund for stimulating agriculture through the purchase and distribution of seeds was transferred to the surplus fund of the Treasury, leaving in each of these two revolving funds only a small balance to meet a few outstanding obligations. On June 30, 1922, $2,559,185.03 additional was transferred to the surplus fund, consisting of $2,438,276.86 in unexpended balances of annual appropriations for the fiscal year 1920 and unobligated balances of several continuing appropriations no longer in active use, and $120,908.17 in final balances under the appropriations for stimulating agriculture and for cooperative agricultural extension work. The total transferred to the surplus fund during the fiscal year was therefore $17,729,185.

At the close of the fiscal year, June 30, 1922, $195,165,739 remained unexpended and available for disbursement during the fiscal year 1923. Of this sum, $5,404,230 represented unexpended balances of appropriations provided by the agricultural act for 1922, $81,971,781 unexpended balances of permanent annual, supplemental, special, and indefinite appropriations and allotments from other departments made for the fiscal year 1922, and $107,789,728 unexpended balances of annual and continuing appropriations for the fiscal year 1921 and prior years. The bulk of these balances consists of $178,703,521 in Federal aid road-building funds and $6,108,038 in forest road and trail construction appropriations, obligated through cooperative road-building agreements within $18,000,000 of their total.

The office of the disbursing clerk received, examined, and paid 189,509 vouchers and pay rolls during the year, requiring the issuance of 341,447 checks on the Treasurer of the United States. In addition, 30,180 checks were issued against funds deposited in the disbursing clerk's special account with the Treasurer.

Of the checks issued, 228 were lost in transit through the mails or by the payees, and were duplicated by this office after bonds of indemnity had been furnished by the payees as required by law and regulations.

The semimonthly payment of salaries of employees stationed in Washington involved the handling and disbursement of $7,541,121.71 in cash.

During the year 11,765 freight and other accounts were sent to the General Accounting Office for payment.

### PUBLIC MONEYS RECEIVED BY THE DEPARTMENT.

The department received during the fiscal year 1922 from the sources indicated the following amounts which were covered into the Treasury:

| | | |
|---|---|---|
| Deposited to the credit of miscellaneous receipts fund: | | |
| Weather Bureau; Receipts from United States telegraph lines | | $5,216.28 |
| Forest Service: Sales of timber, grazing fees, and use of forest lands (exclusive of receipts to be used for construction of roads and trails for States) | | 4,628,462.42 |
| Bureau of Chemistry— | | |
| Examinations of samples of flour, oleomargarine, etc. | | 295.00 |
| Sale of hearings | | 214.90 |
| Bureau of Biological Survey: Sale of animal skins | | 24,600.48 |
| Bureau of Soils: Sale of kelp, char, potash, and carbon | | 37,606.75 |
| Division of Publications: Sale of maps, prints and lantern slides | | 2,126.02 |
| States Relations Service— | | |
| Sale of products grown at insular experiment stations | | 4,378.35 |
| Sale of card indexes | | 117.44 |
| Bureau of Markets and Crop Estimates— | | |
| Inspection of food products | | 131,791.55 |
| Grain standards appeals | | 53,109.99 |
| Warehouse disputes | | 4,862.00 |
| Sale of cotton standards | | 8,947.80 |
| Sale of loose cotton | | 30,883.57 |
| Sale of grain | | 7,821.62 |
| Collections from Center Market | | 49,360.73 |
| Federal Horticultural Board: Charges for fumigating cars and wagons | | 128,036.50 |
| Seed Grain Loan Committee: Interest on seed grain loans | | 1,415.41 |
| Various bureaus: Miscellaneous collections, including sale of condemned Government property | | 90,118.00 |
| Total deposited to credit of miscellaneous receipts fund | | 5,209,364.81 |
| Deposited to the credit of appropriations for regular work of department: | | |
| Bureau of Animal Industry: Payments by packers for overtime services of meat-inspection employees | | 229,801.62 |
| Bureau of Markets and Crop Estimates: Reimbursement for cost of classifying cotton | | 63,443.28 |
| Various bureaus: Miscellaneous collections, including refunds on unused railroad scrip, etc. | | 30,836.58 |
| Total deposited to credit of appropriations for regular work of department | | 324,081.48 |
| Deposited to the credit of other appropriations administered by the department: | | |
| Bureau of Public Roads: Reimbursement for cost to department of distributing surplus war materials to various States for use in road construction | | 323,016.85 |
| Seed Grain Loan Committee: Repayments by farmers of seed grain loans made to them during fiscal year 1921 from the appropriation of $2,000,000 contained in agricultural act | | 668,742.77 |
| Deposited to the credit of special funds of the Forest Service: | | |
| Receipts from sales of timber, grazing fees, and use of lands, which will be applicable to construction of roads and trails in fiscal year 1923 | $338,576.96 | |
| Amount from deferred grazing fees for fiscal year 1921, received during fiscal year 1922, applicable to road and trail construction in fiscal year 1922 | 161,236.34 | |
| | | 499,813.30 |
| Contributions for cooperative work | | 1,378,374.84 |
| Total deposited to credit of special funds of the Forest Service | | 1,878,188.14 |
| Total receipts during fiscal year 1922 | | 8,403,394.05 |

## STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1839 to 1920, inclusive.]

| Fiscal year. | Amount appropriated. | Amount disbursed. | Amount unexpended. | Fiscal year. | Amount appropriated. | Amount disbursed. | Amount unexpended. |
|---|---|---|---|---|---|---|---|
| 1839.. | $1,000.00 | $1,000.00 | | 1880.. | $210,500.00 | $209,361.72 | $1,138.28 |
| 1840.. | | | | 1881.. | 284,300.00 | 276,448.53 | 7,851.47 |
| 1841.. | | | | 1882.. | 371,500.00 | 362,961.34 | 8,538.66 |
| 1842.. | 1,000.00 | 1,000.00 | | 1883.. | 686,941.00 | 669,486.61 | 17,454.39 |
| 1843.. | | | | 1884.. | 648,140.00 | 645,116.96 | 3,023.04 |
| 1844.. | 2,000.00 | 2,000.00 | | 1885.. | 877,690.00 | 780,694.64 | 96,995.36 |
| 1845.. | 2,000.00 | 2,000.00 | | 1886.. | 825,248.00 | 666,470.89 | 158,777.11 |
| 1846.. | 3,000.00 | 3,000.00 | | 1887.. | 872,715.00 | 843,360.33 | 29,354.67 |
| 1847.. | 3,000.00 | 3,000.00 | | 1888.. | 1,864,730.00 | 1,848,793.56 | 15,936.44 |
| 1848.. | 4,500.00 | 4,500.00 | | 1889.. | 1,975,080.00 | 1,874,189.62 | 100,890.38 |
| 1849.. | 3,500.00 | 3,500.00 | | 1890.. | 1,804,200.00 | 1,605,884.51 | 198,315.49 |
| 1850.. | 5,500.00 | 5,500.00 | | 1891.. | 2,336,502.00 | 2,230,730.15 | 105,771.85 |
| 1851.. | 5,500.00 | 5,500.00 | | 1892.. | 3,538,153.00 | 3,487,759.54 | 50,393.46 |
| 1852.. | 5,000.00 | 5,000.00 | | 1893.. | 3,323,060.00 | 3,138,429.53 | 184,630.47 |
| 1853.. | 5,000.00 | 5,000.00 | | 1894.. | 3,708,500.00 | 3,082,113.70 | 626,386.30 |
| 1854.. | 10,000.00 | 10,000.00 | | 1895.. | 3,611,915.00 | 3,126,030.38 | 485,884.62 |
| 1855.. | 50,000.00 | 50,000.00 | | 1896.. | 3,688,750.00 | 3,199,653.20 | 489,096.80 |
| 1856.. | 30,000.00 | 30,000.00 | | 1897.. | 3,940,532.00 | 3,840,281.45 | 100,250.55 |
| 1857.. | 75,000.00 | 75,000.00 | | 1898.. | 3,572,902.00 | 3,530,510.44 | 42.391.56 |
| 1858.. | 63,500.00 | 63,157.25 | $342.75 | 1899.. | 3,987,202.00 | 3,958,212.73 | 28,989.27 |
| 1859.. | 60,000.00 | 60,000.00 | | 1900.. | 4,127,922.00 | 4,069,503.42 | 58,418.58 |
| 1860.. | 40,000.00 | 40,000.00 | | 1901.. | 4,423,500.00 | 4,358,371.42 | 65,128.58 |
| 1861.. | 60,000.00 | 60,000.00 | | 1902.. | 5,090,433.00 | 5,070,328.28 | 20,104.72 |
| 1862.. | 64,000.00 | 63,704.21 | 295.79 | 1903.. | 6,208,960.00 | 5,927,344.84 | 281,615.16 |
| 1863.. | 80,000.00 | 80,000.00 | | 1904.. | 6,740,024.00 | 6,684,311.63 | 55,712.37 |
| 1864.. | 119,770.00 | 109,270.00 | 10,500.00 | 1905.. | 6,589,540.00 | 6,513,865.63 | 75,674.37 |
| 1865.. | 150,604.00 | 150,496.50 | 107.50 | 1906.. | 8,370,690.00 | 8,174,510.02 | 196,179.98 |
| 1866.. | 167,787.82 | 167,787.82 | | 1907.. | 11,116,440.00 | 9,916,252.70 | 1,200,187.30 |
| 1867.. | 199,100.00 | 199,100.00 | | 1908.. | 13,613,040.00 | 13,170,739.63 | 442,300.37 |
| 1868.. | 279,020.00 | 277,094.34 | 1,925.66 | 1909.. | 16,063,106.00 | 15,756,766.45 | 306,339.55 |
| 1869.. | 210,198.00 | 210,198.00 | | 1910.. | 17,136,736.00 | 16,725,796.13 | 410,939.87 |
| 1870.. | 156,440.00 | 151,596.93 | 4,843.07 | 1911.. | 21,832,636.00 | 21,368,954.64 | 463,681.36 |
| 1871.. | 188,180.00 | 186,876.81 | 1,303.19 | 1912.. | 22,403,209.00 | 20,986,207.28 | 1,417,001.72 |
| 1872.. | 197,070.00 | 195,977.25 | 1,092.75 | 1913.. | 22,662,315.00 | 21,971,927.22 | 690,387.78 |
| 1873.. | 202,440.00 | 201,321.22 | 1,118.78 | 1914.. | 24,086,945.00 | 23,348.321.00 | 738,624.00 |
| 1874.. | 259,871.00 | 235,946.78 | 23,924.22 | 1915.. | 28,880,075.00 | 28,113,863.88 | 766,211.12 |
| 1875.. | 357,380.00 | 341,079.83 | 16,300.17 | 1916.. | 28,004,082.00 | 27,594,068.32 | 410,013.68 |
| 1876.. | 264,120.00 | 213,843.64 | 50,276.36 | 1917.. | 36,133,100.00 | 34,360,180.56 | 1,772,919.44 |
| 1877.. | 333,687.00 | 327,206.23 | 6,480.77 | 1918.. | 71,130,513.00 | 65,969,604.07 | 5,160,908.93 |
| 1878.. | 327,640.00 | 326,634.94 | 1,005.06 | 1919.. | 114,087,216.00 | 108,937,668.18 | 5,149,547.82 |
| 1879.. | 217,400.00 | 217,360.00 | 40.00 | 1920.. | 142,733,924.00 | 70,265,464.64 | [1] 72,468,459.36 |

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[1] Does not include unexpended balances of annual and continuing appropriations from prior fiscal years of $124,248,854; total balance available for further disbursement in fiscal year 1921, $196,717,313.

### STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1921 and 1922.]

| Fiscal year. | Appropriations. | | | | Disbursements. | | | | Unexpended balances. | | | | Amounts turned into surplus fund at close of fiscal year. | Balance available for disbursement in next fiscal year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agricultural appropriation act. | Permanent annual, supplemental, special, and indefinite appropriations and allotments from other departments. | Unexpended balances of appropriations for prior fiscal years, available for further disbursement. | Total available for disbursement. | Agricultural appropriation act. | Permanent annual, supplemental, special, and indefinite appropriations and allotments from other departments. | Appropriations for prior fiscal years. | Total disbursed during fiscal year. | Agricultural appropriation act. | Permanent annual, supplemental, special, and indefinite appropriations and allotments from other departments. | Appropriations for prior fiscal years. | Total unexpended balance at close of fiscal year. | | |
| 1921......... | $31,712,784 | $120,461,189 | $196,717,313 | $348,891,286 | $26,234,726 | $15,854,738 | $76,475,969 | $118,565,433 | $5,478,058 | $104,606,451 | $120,241,344 | $230,325,853 | $5,188,462 | $225,137,391 |
| 1922......... | 36,404,259 | 98,642,659 | 225,137,391 | 360,184,309 | 31,000,029 | 16,670,878 | 99,618,478 | 147,289,385 | 5,404,230 | 81,971,781 | 125,518,913 | 212,894,924 | 17,729,185 | 195,165,739 |

# REPORT OF THE CHIEF OF THE DIVISION OF PUBLICATIONS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF PUBLICATIONS,
*Washington, D. C., September 18, 1922.*

SIR: I have the honor to submit herewith a report on the work of the Division of Publications for the fiscal year ended June 30, 1922.

Respectfully,

JOHN L. COBBS, Jr.,
*Chief of Division.*

Hon. H. C. WALLACE,
*Secretary of Agriculture.*

## SUMMARY.

Important facts regarding the work of the Division of Publications in the fiscal year 1922 may be summarized as follows:

(1) Investigation of the publication work of the department by a committee of farm-paper editors at the request of the Secretary.

(2) Press Service and Office of Exhibits detached from the division and placed under the Office of the Secretary.

(3) Legislation which resulted in the suspension of the Good Roads Magazine, Journal of Agricultural Research, and Special Information Service.

(4) Combination of the Market Reporter, Crop Reporter, and National Weather and Crop Bulletin into a weekly publication known as Weather, Crops, and Markets. The Weekly News Letter was discontinued and a "house organ," known as the Official Record, established.

(5) The consolidation in this division of the addressing and duplicating work of the department.

(6) The return to the Treasury of $183,848.79 of the printing appropriation for the fiscal year and a carry over of unfinished work of approximately $141,000.

(7) There were distributed 35,249,498 copies of publications, and 388 new publications were issued. Of these, 57 were Farmers' Bulletins, 113 were Department Bulletins, and the remainder miscellaneous publications.

(8) Thirty-three new motion pictures were completed, 21 old films were revised, and work begun on 28 additional new films.

(9) A turnover of 40.24 per cent in the $960 clerical grade and of 27.7 per cent in the photographers and draftsmen.

## LEGISLATION AFFECTS PERIODICALS.

The sundry civil act of March 4, 1921, carried a provision to the effect that all Government periodicals not specifically authorized by Congress by December 1, 1921, should be suspended on that date. A bill providing for the continuance of these periodicals passed the Senate but was not acted on in the House before adjournment, and on December 1 the law went into effect. All periodicals issued by the department were temporarily suspended. Subsequently a ruling by the Congressional Joint Committee on Printing permitted the publication of such statistical and administrative matter as might be certified by the Secretary of Agriculture as being necessary for the conduct of the routine business of the department. Under this permission the proposed combination of the Crop Reporter, the Market Reporter, and the National Weather and Crop Bulletin into a weekly publication known as Weather, Crops, and Markets, was made effective January 1. The Weekly News Letter was discontinued, and a house organ called the Official Record was inaugurated on that date, while the continuance of the Experiment Station Record, the Monthly Weather Review, and the Clip Sheet was secured. Permission was not secured for the continued publication of the Good Roads Magazine, the Journal of Agricultural Research, and the Special Information Service, and publication of these periodicals had not been resumed at the end of the fiscal year. Legislation in the spring of 1922 provided that periodicals might be issued by the heads of departments upon the approval of the Bureau of the Budget, but formal approval by that bureau of periodicals had not been received on June 30, 1922.

## PRINTING FUNDS RETURNED TO TREASURY.

The regular printing and binding fund for the fiscal year 1922 was $725,000. There was also available the deficiency appropriation of $125,000 made during the latter part of the fiscal year 1921 but not used in that year. Thus, the department had $850,000 available for printing. In accordance with instructions from the Secretary the deficiency appropriation was held primarily for the purpose of publishing manuscripts which had accumulated in the department because of the lack of printing funds. Approximately $184,000 of the printing fund was returned to the Treasury.

## EDITORIAL FORCE MUST BE STRENGTHENED.

The editorial work was handicapped by the resignation, in the fall of 1921, of the chief editor, who left the department to take a position in the War Finance Corporation, paying a salary 50 per cent larger than he had received here. The place was vacant two months before a competent person was found. So far as the prompt preparation of copy and the transmittal of manuscripts to the Public Printer is concerned the editorial work has been in a fairly satisfactory condition. It has been, and is, however, seriously handicapped by a shortage of capable editors. Up to this time it has not been possible to find well-qualified persons who would accept the small salaries available.

## A NEW STYLE MANUAL.

A new style manual of the Government Printing Office was issued during the past fiscal year. It has been approved by the Joint Committee on Printing, and the Permanent Conference on Printing adopted a resolution that it be "approved for adoption as the style to be used for all Government departments." This department made a number of recommendations to the Public Printer in regard to certain matters of style and terminology. Some of these were accepted and appear in the style manual. Some bureaus of the department insist on following their own terminology and style. The result is a lack of uniformity in department publications and unnecessary expense and delay in handling copy and proofs. It seems obvious that this department should at least be consistent in the terminology and style of its own publications. It seems also that the Department of Agriculture should be the final authority on the terminology and adoption of new words pertaining to agriculture, not only that their use may become uniform within the department, but that they may be adopted by dictionaries, educators, and the public. Some agency is needed within the department to make final decisions in regard to many agricultural terms about which there is no uniformity at present. It is recommended, therefore, that a board of terminology, whose decisions in such matters shall be final and binding upon all bureaus of the department, be created by the Secretary.

## COST OF PUBLICATIONS OF THE YEAR.

**The following tables summarize the expenditures from each of the printing funds available during the fiscal year 1922 for each class of publications by bureaus:**

*Expenditures from the regular fund for printing and binding, with the number of copies (arranged by classes of printing and by bureaus and offices), for the fiscal year ended June 30, 1922.*

[Quantities and costs are those billed by the Government Printing Office for deliveries made during the year.]

| Bureau. | Grand total. | | Total publications. | | Farmers' Bulletins. | | Department bulletins. | | Department circulars. | | Secretary's circulars. | | Reports, etc.[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. |
| Accounts | 406,739 | $1,341.08 | 513 | $32.43 | | | | | | | | | 500 | $23.05 |
| Animal Industry | 2,322,937 | 14,299.83 | 487,354 | 10,253.23 | 209,430 | $3,385.26 | 62,600 | $2,669.05 | 12,000 | $1,232.68 | 1,000 | $21.62 | 5,000 | 315.08 |
| Biology | 877,467 | 8,760.64 | 219,535 | 5,892.10 | 160,000 | 4,041.57 | 4,500 | 556.17 | 7,500 | 182.16 | | | 6,500 | 612.84 |
| Chemistry | 967,442 | 12,118.26 | 322,634 | 9,203.90 | | | 28,000 | 2,403.96 | 1,000 | 140.55 | 15,000 | 148.31 | 6,500 | 239.54 |
| Entomology | 1,486,983 | 17,791.14 | 607,080 | 14,905.01 | 394,434 | 9,339.61 | 60,500 | 3,934.82 | 135,000 | 785.67 | | | 2,500 | 276.19 |
| Farm management | 517,022 | 7,297.86 | 81,637 | 4,905.79 | | | 56,600 | 3,988.45 | 18,000 | 547.38 | | | | |
| Federal Horticultural Board | 678,176 | 3,841.38 | 100,011 | 2,040.22 | | | | | | | | | 3,500 | 696.23 |
| Forest Service | 5,445,619 | 31,730.56 | 342,836 | 9,311.79 | | | 15,500 | 2,757.38 | 124,500 | 2,190.63 | 10,000 | 162.36 | 15,000 | 481.90 |
| Insecticide and Fungicide Board | 136,556 | 1,072.03 | 39,506 | 851.68 | | | | | | | 2,000 | 15.92 | 2,500 | 25.68 |
| Library | 268,121 | 2,914.59 | 750 | 72.37 | | | | | | | | | 750 | 67.17 |
| Markets and Crop Estimates | 8,229,413 | 83,725.74 | 4,087,392 | 67,623.83 | 75,000 | 2,285.21 | 196,500 | 10,926.80 | 16,000 | 160.42 | 12,000 | 119.13 | 2,500 | 35.73 |
| Plant Industry | 2,528,893 | 41,598.74 | 1,135,310 | 35,531.63 | 494,815 | 10,627.91 | 190,000 | 16,400.82 | 156,000 | 3,249.01 | | | 2,500 | 169.47 |
| Public Roads | 1,070,170 | 11,181.73 | 179,459 | 7,970.59 | 120,000 | 2,933.38 | 10,700 | 2,134.16 | 21,000 | 271.56 | | | 1,500 | 198.15 |
| Publications | 30,169,311 | 260,119.21 | 27,800,207 | 253,121.98 | 21,188,792 | 199,420.57 | | | | 54.13 | | | | |
| Secretary | 1,199,090 | 6,729.08 | 73,019 | 2,898.10 | | | | | 4,500 | 35.06 | | | | |
| Soils | 167,176 | 29,077.73 | 33,813 | 28,691.87 | | | | | | | | | | |
| States Relations Service | 518,260 | 30,486.12 | 418,464 | 26,598.50 | | | 14,000 | 399.88 | 195,500 | 3,967.36 | | | 50,000 | 5,012.22 |
| Weather Bureau | 10,893,671 | 39,337.09 | 44,462 | 13,301.72 | | | | | | | | | 500 | 57.31 |
| Total | 67,883,046 | 603,422.81 | 35,973,982 | 493,206.74 | 22,642,471 | 232,033.51 | 638,900 | 46,171.49 | 691,000 | 12,816.61 | 40,000 | 467.34 | 99,750 | 8,240.56 |

| Bureau. | Periodicals. |  | Congressional publications.[2] |  | Compilations of laws, manuals, fiscal regulations, etc. |  | Separates and unnumbered pamphlets. |  | Administrative circulars, orders, decisions, notices, etc. |  | Forms, letters, and other administrative printing. |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. |
| Accounts |  |  | 6 | $6.73 |  |  |  |  | 7 | $2.65 | 406,226 | $1,308.65 |
| Animal Industry |  |  | 60 | 30.84 |  |  | 79,925 | $723.65 | 117,339 | 1,875.05 | 1,835,583 | 4,046.60 |
| Biology |  |  | 10 | 7.74 |  |  | 21,000 | 357.59 | 20,025 | 134.03 | 657,932 | 2,868.54 |
| Chemistry |  |  | 10 | 12.94 |  |  | 1,115 | 33.40 | 271,009 | 6,225.20 | 644,808 | 2,914.36 |
| Entomology |  |  | 24 | 11.30 |  |  | 14,600 | 547.72 | 22 | 9.70 | 879,903 | 2,886.13 |
| Farm Management |  |  | 24 | 11.29 |  |  | 2,000 | 57.14 | 5,013 | 301.53 | 435,385 | 2,392.07 |
| Federal Horticultural Board |  |  | 4 | 6.22 |  |  | 2,000 | 7.46 | 94,507 | 1,330.31 | 578,165 | 1,801.16 |
| Forest Service |  |  | 14 | 13.44 | 16,000 | $831.81 | 91,600 | 1,750.05 | 70,222 | 1,124.22 | 5,102,783 | 22,418.77 |
| Insecticide and Fungicide Board |  |  | 4 | 6.22 |  |  |  |  | 35,002 | 803.86 | 97,050 | 220.35 |
| Library |  |  |  | 5.20 |  |  |  |  |  |  | 267,371 | 2,842.22 |
| Markets and Crop Estimates | 3,771,700 | $53,446.20 | 2,042 | 41.61 |  |  | 5,000 | 198.00 | 6,650 | 410.73 | 4,142,021 | 16,101.91 |
| Plant Industry |  |  | 14 | 13.94 |  |  | 288,385 | 5,017.25 | 3,596 | 53.23 | 1,393,583 | 6,067.11 |
| Public Roads | 23,000 | 2,325.40 | 1,030 | 23.80 |  |  | 2,200 | 70.66 | 29 | 13.48 | 890,711 | 3,211.14 |
| Publications | 4,402,700 | 38,310.08 | 28,910 | 9,144.24 |  |  | 1,833,500 | 5,872.06 | 4,305 | 320.90 | 2,369,104 | 6,997.23 |
| Secretary |  |  | 18,553 | 1,358.72 | 49,933 | 1,487.02 |  |  | 33 | 17.30 | 1,126,071 | 3,830.98 |
| Soils |  |  | 32,006 | 28,618.22 |  |  | 1,800 | 71.25 | 7 | 2.40 | 133,363 | 385.86 |
| States Relations Service | 154,800 | 16,494.97 | 26 | 11.80 |  |  | 4,100 | 125.46 | 38 | 556.81 | 99,796 | 3,887.62 |
| Weather Bureau | 22,275 | 8,186.67 | 1,011 | 3,952.41 |  |  | 19,920 | 796.87 | 756 | 308.46 | 10,849,209 | 26,035.37 |
| Total | 8,374,475 | 118,763.32 | 83,748 | 43,276.66 | 65,933 | 2,318.83 | 2,367,145 | 15,628.56 | 628,560 | 13,489.86 | 31,909,064 | 110,216.07 |

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[1] Annual Reports of the chiefs of bureaus and of the Agricultural experiment stations in Alaska, Guam, Hawaii, Porto Rico, and the Virgin Islands.

[2] Includes Yearbook; Soil Survey reports, Annual Reports of Department of Agriculture (bound volume); Reports of Secretary of Agriculture; press copies and summary of same; a few copies each of the Congressional Directory, Congressional Record, Book of Estimates, Alternate Budget, and certain acts, resolutions, and reports of Congress of interest to the department purchased on printing requisition; and composition and electrotyping of reports made to Congress but not printed for the department.

*Expenditures from the deficiency appropriation, fiscal year 1922.*

| Bureau. | Grand total. | | Publications. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Total publications. | | Farmers' Bulletins. | | Department Bulletins. | |
| | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. |
| Animal industry |  | $72.88 |  | $72.88 |  | $72.88 |  |  |
| Biological Survey | 3,500 | 519.13 | 3,500 | 519.13 |  |  | 3,500 | $373.48 |
| Chemistry | 3,000 | 400.77 | 3,000 | 400.77 |  |  | 3,000 | 400.77 |
| Entomology |  | 380.26 |  | 380.26 |  | 210.58 |  | 169.68 |
| States Relations Service | 200,000 | 5,419.43 | 200,000 | 5,419.43 | 200,000 | 5,378.03 |  | 41.40 |
| Journal of Agricultural Research | 40,102 | 8,394.72 | 40,102 | 8,394.72 |  |  |  |  |
| Forest Service | 39,500 | 4,961.53 | 39,500 | 4,961.53 | 25,000 | 1,534.87 | 6,500 | 3,152.65 |
| Library | 12,822 | 11,635.00 |  | 822.00 |  |  |  |  |
| Public Roads | 34,000 | 5,146.51 | 34,000 | 5,146.51 | 30,000 | 1,072.60 | 3,000 | 2,777.34 |
| Soils |  | 1,654.62 |  | 1,654.62 |  |  |  | 1,654.62 |
| Farm Management |  | 866.62 |  | 866.62 |  | 217.88 |  | 648.74 |
| Plant Industry | 16,500 | 4,078.95 | 16,500 | 4,078.95 |  | 311.98 |  | 55.35 |
| Weather Bureau | 58,449 | 19,197.98 | 57,750 | 17,051.79 |  |  |  |  |
| Total | 407,873 | 62,728.40 | 394,352 | 49,769.21 | 255,000 | 8,798.82 | 16,000 | 9,274.03 |

| Bureau. | Publications. | | | | | | | | Forms, letters, etc. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Department circulars. | | Reports, etc. | | Periodicals. | | Separates and unnumbered pamphlets. | | | |
| | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. | Copies. | Cost. |
| Biological Survey |  |  |  | $145.65 |  |  |  |  |  |  |
| Journal of Agricultural Research |  |  |  |  | 40,000 | $8,373.56 | 102 | $21.16 |  |  |
| Forest Service | 8,000 | $274.01 |  |  |  |  |  |  |  |  |
| Library |  | 822.00 |  |  |  |  |  |  | 12,822 | $10,813.00 |
| Public Roads |  |  | 1,000 | 1,296.57 |  |  |  |  |  |  |
| Plant Industry | 4,000 | 358.80 |  |  |  |  | 12,500 | 3,352.82 |  |  |
| Weather Bureau |  |  |  | 900.00 |  |  | 57,750 | 16,151.79 | 699 | 2,146.19 |
| Total | 12,000 | 1,454.81 | 1,000 | 2,342.22 | 40,000 | 8,373.56 | 70,352 | 19,525.77 | 13,521 | 12,959.19 |

## NEW PUBLICATIONS.

*New publications issued during the year ended June 30, 1922.*

| | |
|---|---|
| Department bulletins | 113 |
| Department circulars | 45 |
| Soil surveys | 29 |
| Yearbook separates | 38 |
| Journal of Agricultural Research separates | 49 |
| Secretary circulars | 3 |
| Service and regulatory announcements | 54 |
| Total | 331 |
| Reprints | 36 |
| Total | 367 |
| Farmers' Bulletins, new | 57 |
| Farmers' Bulletins, reprints | 534 |
| Total | 958 |
| Number of orders of job printing | 2,289 |

*New Farmers' Bulletins issued during the year ended June 30, 1922.*

No.
1198. Swarm Control.
1201. Motor Trucks on Eastern Farms.
1204. Northwestern Apple Packing Houses.
1200. Tuberculosis of Fowls.
1210. Measuring and Marketing Farm Timber.
1199. Judging Sheep.
1211. Home Canning of Fruits and Vegetables.
1207. Milk and Its Uses in the Home.
1217. The Green-bug or Spring Grain-aphis.
1209. Planting and Care of Street Trees.
1221. Standard Varieties of Chickens. IV. The Ornamental Breeds and Varieties.
1214. Farm Dairy Houses.
1223. The Chinch Bug and Its Control.
1225. The Potato Leafhopper and Its Control.
1219. Floors and Floor Coverings.
1226. Take-all of Wheat and Its Control.
1227. Sewage and Sewerage of Farm Homes.
1203. The Angora Goat.
1218. Beef Production in the Corn Belt.
1231. Drying Crude Drugs.
1232. Seed Marketing Hints for the Farmer.
1228. A Week's Food for an Average Family.
1224. Wheat Scab and Its Control.
1233. Tomatoes for Canning and Manufacturing.
1220. Insect and Fungous Enemies of the Grape.
1235. Game Laws for 1921.
1230. Chimneys and Fireplaces: How to Build Them.
1237. Pineapple Culture in Florida.
1229. Utilization of Alfalfa.
1238. Laws Relating to Fur-bearing Animals, 1921.
1241. An Improved Method of Making Sugar-beet Sirup.
1208. Trees for Town and City Streets.
1246. The Peach Borer: How to Prevent or Lessen Its Ravages.
1249. Olive Growing in the Southwestern United States.
1242. Permanent Fruit and Vegetable Gardens.
1248. The Sugar-beet Nematode in the Western States.
1247. American Moles as Agricultural Pests and as Fur Producers.
1234. Gullies: How to Control and Reclaim Them.
1251. Standard Varieties of Chickens. V. The Bantam Breeds and Varieties.
1239. Community Bird Refuges.
1222. Beekeeping in the Tulip-tree Region.
1216. Beekeeping in the Buckwheat Region.
1215. Beekeeping in the Clover Region.
1254. Important Cultivated Grasses.
1253. Seed Peas for the Canner.
1259. A Sawfly Injurious to Young Pines.
1252. Sawflies Injurious to Rose Foliage.
1257. Insects Injurious to the Mango in Florida and How to Combat Them.
1258. Webworms Injurious to Cereal and Forage Crops and Their Control.
1255. The Production of Peas for Canning.
1250. Green Manuring.
1261. The Avocado: Its Insect Enemies and How to Combat Them.
1260. Stored-grain Pests.
1262. The Boll-weevil Problem: Methods of Reducing Damage.
1266. Preparation of Peaches for Market.
1267. Utilization of Flue-heated Tobacco Barns for Sweet-potato Storage.
1243. The Border Method of Irrigation.

### FIELD PRINTING DONE ON CONTRACT BY PRINTERS OUTSIDE THE DISTRICT OF COLUMBIA AS OF AUGUST 21, 1922.

In addition to the printing done for the department at the Government Printing Office, a small quantity of emergency work was done by commercial printers at various points outside the District of Columbia. The amounts, by bureaus, were as follows:

| | |
|---|---|
| Animal Industry | $15.50 |
| Biological Survey | 34.50 |
| Entomology | 493.28 |
| Forest Service | 3.50 |
| Public Roads | 78.35 |
| Federal Horticultural Board | 10.58 |
| Weather Bureau | 30.75 |
| Markets and Crop Estimates | 663.75 |
| Office of Farm Management | 10.75 |
| Plant Industry | 620.00 |
| Office of the Secretary | 52.00 |
| Total | 2,012.96 |

*Printing done at the Government Printing Office but charged to special funds of bureaus as of August 19, 1922.*

| Bureaus. | Bills. | Estimates. | Total. |
|---|---|---|---|
| Animal Industry | $17,286.81 | $3,492.36 | $20,779.17 |
| States Relations Service | 508.00 | 1,928.13 | 2,436.13 |
| Public Roads | 4,273.51 | 2,276.74 | 6,550.25 |
| Office of the Secretary | 842.74 | | 842.74 |
| Markets and Crop Estimates | 4,999.22 | 3,146.96 | 8,146.18 |
| Fixed Nitrogen Research Laboratory | 229.97 | | 229.97 |
| Packers and Stockyards Administration | 380.88 | 117.10 | 497.98 |
| Total | 28,521.13 | 10,961.29 | 39,482.42 |

### PAPERS APPROVED FOR PUBLICATION IN OUTSIDE JOURNALS.

In addition to the material published by the department, articles were prepared by members of the department for publication in trade, scientific, and popular periodicals. The administrative regulations of the department provide that these articles be approved by the Assistant Secretary and this review has been delegated to the editorial section of this division in order to be sure that they conform to department policy. The number of papers approved during the past year is shown below:

| | |
|---|---|
| Animal Industry | 66 |
| Biological Survey | 96 |
| Chemistry | 134 |
| Entomology | 133 |
| Fixed Nitrogen Research Laboratory | 14 |
| Farm Management | 6 |
| Forest Service | 142 |
| Markets and Crop Estimates | 64 |
| Plant Industry | 185 |
| Public Roads | 15 |
| Soils | 19 |
| States Relations Service | 20 |
| Weather Bureau | 5 |
| Total | 899 |

These articles do not represent the total number prepared for publication by members of the department. According to the lists published in the Official Record from January 1 to June 30 there were 96 articles prepared for publication in outside journals which were not referred to this division for approval. It may be assumed that during the early part of the year a proportionate number of articles were prepared for publication without the approval of this division. A continuance of this practice will make the record kept in this division of little value.

The careful reading of these articles and entry of title, etc., for record requires a large part of the time of one person. A complete record of articles written for outside publication should be kept, but in view of the way in which they are now handled it is not apparent that their review in this division serves any useful purpose. On the contrary, it is felt that the present regulation is distasteful to many of the workers in the department and serves only to encourage them to write under assumed names or not to write as much as they otherwise would. It is consequently recommended that the regulation be modified so as to place upon the bureaus responsibility for statements made in articles published and for keeping a record of them.

## INDEXING WORK.

There were no outstanding changes in the method of conducting the indexing work during the fiscal year. The volume of work completed was in some respects larger than in previous years and the current work was kept more closely up to date than had been possible in the past. A total of 27,232 pages of department publications, and 2,126 pages of Congressional Record, were indexed. This included 75 Farmers' Bulletins and 175 Department Bulletins.

Material assistance was rendered the library of the department in rearranging and bringing up to date a duplicate card index formerly maintained in this division, but which was turned over to the library two years ago. This index covers all important statements in all department publications and should be invaluable to research workers. Although no provision was made at that time to keep the index up to date, and for lack of space it has not been possible to give it much attention and care, it was reported that the index has been of material assistance to the research workers of the department and arrangements have been made to supply duplicate copies of index cards prepared in this division, so that the value of the index may be increased.

## DISTRIBUTION.

The efforts toward securing better distribution of department publications reported for the year 1921 were continued with success. During the fiscal year 1922, 35,249,498 publications, including periodicals, were distributed. This was 2,881,867, or about 10 per cent, more than the total for the fiscal year 1921. Of the publications distributed, 14,487,790 were Farmers' Bulletins and the remainder were miscellaneous publications, including 8,731,700 lists of Farmers' Bulletins. The number of Farmers' Bulletins distributed showed an increase of 1,721,298, or about 13 per cent more than the previous fiscal year. Members of Congress distributed 10,096,722 copies, which was the largest number of bulletins distributed by Congress since 1918. As large as was the distribution of this class of publications, it would have been materially increased had more bulletins been available. The number of Farmers' Bulletins actually distributed corresponds very closely with the number issued, 14,565,113, and the balance on hand on July 1, 1922, of 6,324,572 is almost the same as that carried over from the previous year. There were also 4,506,517 miscellaneous publications on hand on July 1, 1922, making a total carry over to the fiscal year 1923 of 10,831,089.

The accrued credit of Farmers' Bulletins to Members of Congress on July 1, 1922, was 22,419,501. Taking into account the bulletins on hand, the deficit was reduced to 16,094,929. This deficit, as has been explained in previous reports, is due to the method of distribution necessitated by the wording of the appropriation act. It is believed that this wording should be changed so that the entire distribution of Farmers' Bulletins be made by the department, or, failing this, to provide that undistributed quotas shall revert to the department at the end of each fiscal year as formerly.

The following table shows the distribution of the miscellaneous publications of the different bureaus:

| | |
|---|---:|
| Office of the Secretary | 90,883 |
| Insecticide and Fungicide Board | 37,146 |
| Federal Horticultural Board | 114,488 |
| Division of Accounts and Disbursements | 525 |
| Farm Management | 88,318 |
| Weather Bureau | 850 |
| Office of the Solicitor | 4,402 |
| Bureau of Animal Industry | 1,142,414 |
| Biological Survey | 97,322 |
| Bureau of Chemistry | 263,513 |
| Bureau of Entomology | 201,093 |
| States Relations Service | 614,511 |
| Forest Service | 278,220 |
| Library | 405 |
| Bureau of Plant Industry | 472,145 |
| Division of Publications | 12,243,498 |
| Bureau of Public Roads | 56,340 |
| Bureau of Soils | 19,310 |
| Bureau of Markets and Crop Estimates | 5,036,325 |
| Total | 20,761,708 |

Further efforts were made during the year to simplify the handling of the great volume of correspondence received by the distribution section. Form letters were perfected which cut this work down to a minimum, although it was necessary to employ temporary help during the rush period, when as many as 4,500 requests per day were received.

Some idea of the amount of work involved in the distribution section can be gained from the total number of publications distributed and from the fact that 643,369 communications were received and handled during the fiscal year. Without question the distribution work is one of the important methods of contact between the public and the department. The importance of the work, however, is not generally recognized. There has been too much of a tendency to consider it merely routine and to think that it can be done satisfactorily by any kind of help. More friends are made or lost for the department by the service they obtain from the distribution section than any other single activity. The work itself requires a knowledge of departmental publications which can be gained only by experience. The effort in the section is to render as complete service as possible and to answer all communications promptly and fully either by sending the publications requested or by letter, or by reference of the request to the bureau or other department of Government concerned with the subject matter. The distribution section of this division is a bureau of information not only for Members of Congress, but also for a large part of the general public who have contact with the Department of Agriculture, but whose knowledge of other Government work is exceedingly meager. Inquiries covering the whole field of agriculture, also ranging all the way from whether an "ace is a face card" to a request that the applicant be put in touch with a "good-looking capable girl qualified to make a good wife for a lonely farmer." were received. A surprisingly large number of these miscellaneous requests were satisfactorily answered. The distribution work properly handled can be made a most powerful agency for creating favorable sentiment for the department. Improperly handled, it can create more enemies in a week than can be placated in 10 years. Provision should be made for salaries which will attract capable, bright people to the work.

## MAILING-LIST REVISION.

Revision of the mailing lists begun in 1921 was continued with further notable improvement. Complete information regarding all the lists of the department was filed and made available for the distribution work. In the fall of 1921 one large list to which had been sent in the past all Farmers' Bulletins as issued was discontinued after an investigation had shown that many people on the list had been added to it without due consideration and had no real use for the publications. Out of a total of about 8,000 names replies were received from less than 100, and of these it was necessary to make provision for only about 20 persons who could actually show a real use and need for all Farmers' Bulletins. The result was that approximately 8,000 copies of the initial edition of each Farmers' Bulletin became available for distribution to applicants to this division.

During the year there was a net reduction of 95,406 in the number of names on the various mailing lists maintained at the Office of the Superintendent of Documents, due to the activities of this department in conducting the revision. In addition, a number of obsolete lists, totaling 30,000 names, were destroyed, and a number of new lists turned over to this division in connection with the consolidation of the addressing work were established on stencil. Lists in the addressing, duplicating, and mailing section of this division were reduced by 20,000 names, while an additional 20,000 stenciled addresses were transferred to the various field services. Arrangements were made during the fiscal year for the establishment of a new master index of names on lists to supersede the incomplete and inaccurate index now in this division. When finally established this index should enable this division to cut duplication on lists used in distributing department publications to a minimum. It will, however, be necessary to provide adequate assistance for caring for this work.

## ILLUSTRATIONS WORK.

As has been the case for several years, the demand upon the drafting section for illustrative work showed a material increase and it proved impossible for the available force to keep the work current. It became necessary, therefore, to refuse all work except that connected with the publications of the department, although many bureaus had on hand work of the sort regularly done in this division in the past. As has been explained in other reports, the difficulty is to secure and retain a full force of competent draftsmen at the low salaries available. One position at $1,200 remained vacant during the entire year. Death and resignation was responsible for a large turnover in the drafting force. It is felt, moreover, that there should be in the department a drafting section capable of doing high-class illustrative work for all of the bureaus. At present the section of illustrations is a training school for promising young draftsmen. The volume of work produced during the past fiscal year was 70 per cent greater than for the previous year. The adoption of a standard cover page for Farmers' Bulletins and the necessity of changing many old covers to fit a large press at the Government Printing Office, which was bought especially for printing this class of publications, has involved considerable work. It is possible that the use of standard covers may eventually reduce the amount of work needed on this class of publications. The following table shows the number of drawings made for the various bureaus of the department:

*Drawings made for the various branches of the department.*

| | |
|---|---|
| Bureau of Animal Industry | 267 |
| Biological Survey | 123 |
| Bureau of Plant Industry | 551 |
| Bureau of Chemistry | 102 |
| Bureau of Entomology | 555 |
| Federal Horticultural Board | 6 |
| Farm Management | 466 |
| Forest Service | 215 |
| Journal of Agricultural Research | 307 |
| Bureau of Markets and Crop Estimates | 154 |
| Bureau of Public Roads | 24 |
| Office of the Secretary | 164 |
| States Relations Service | 81 |
| Weather Bureau | 11 |
| Publications | 1,138 |
| Unidentified | 1 |
| Total | 3,745 |

The filing of the cuts of the department under the approved plan reported last year was completed with satisfactory results. Early in 1922, however, the Public Printer, acting under a provision of the printing law of 1895, retained all cuts used in department publications. This has resulted in much confusion and delay, since the cuts are often used in other bulletins than the one in which they originally appeared. It has come to pass, therefore, that some of the cuts used in given publications are in custody of the department while others are retained by the Public Printer, and when reprints are requested or when electrotypes are desired by outside parties it is difficult to get all the cuts together. This has also made it exceedingly difficult for persons outside the department to secure electrotypes of the cuts of illustrations in department publications. It has been the custom in the past to furnish original cuts to a commercial engraving house, where the electrotypes could be prepared very promptly and the cost billed against the purchaser. The Government Printing Office will make electros only when payment is made in advance, and this necessitates a considerable amount of correspondence and delay. Seven hundred and seventy-five cuts were sent to the Printing Office for reprinting publications. Three hundred and ninety-five cuts were duplicated by electrotyping firms for use in outside publications.

Because of the volume of work a plan was inaugurated during the year of calling on the various bureaus of the department to reimburse the illustrations section for photographic material used in doing work for these bureaus. This made it possible for the division to finance the work out of its own funds, whereas in previous years it had been necessary to call upon the bureaus to purchase material because the appropriations in the division were inadequate. There was a slight falling off in the number of contact prints made, largely because of the discontinuance of the Special Information Service. The bromide enlargement work, however, which is considerably more difficult and exacting, has almost doubled, and if it continues to increase the assignment of additional help will be necessary. The new projection printer purchased last year has been of great assistance in this work. Prints of department photographs to the value of $1,325.28 were made for outside parties and this amount turned over to the disbursing office to be covered into the Treasury. The attached summary shows the output of photographic work:

*Output of photographic work, fiscal year 1922.*

| | |
|---|---|
| Prints | 97,068 |
| Negatives | 7,460 |
| Prints mounted | 4,638 |
| Lantern slides | 12,806 |
| Developing | 4,112 |
| Bromides | 4,619 |
| Maps and bromides mounted | 2,779 |
| Bromides colored | 1,037 |
| Solar bromides | 277 |
| Transparencies colored | 66 |
| Photomicrographs | 32 |
| Photostats | 14,852 |
| Autochromes | 8 |
| Transparencies | 66 |

In the latter part of June the section of illustrations was moved from the quarters in the Bieber Building, which it had occupied for some years, to 220 Linworth Place, in order to make room for the Bureau of Agricultural Economics. In some respects the new quarters are entirely satisfactory, but it was not possible to obtain enough space to bring together all the photographic work. It is extremely desirable that the basement floor of the Linworth Place building be secured in order to make this possible, and it is believed that such an arrangement will materially facilitate the work of the section.

## MOTION PICTURES.

Definite accomplishments of the motion-picture office and laboratory during the fiscal year 1922 include the following:

Completion of 33 new motion pictures.

Revision of 21 old films.

Beginning of editorial or production work, or both, on 28 new films.

Addition of 274 new prints, totaling 547 reels, to the department's stock.

Circulation of department films through extension workers and others to a total estimated audience of between four and five million people.

Authorization of sale of 236 prints, totaling 289 reels, of department films to cooperating or outside institutions, at a cost to purchasers of $9,845.35, compared with $6,179.60 in the fiscal year 1921.

Improvement in the subject-matter content and photographic quality of our motion pictures.

Addition of photographic equipment enabling the production of better and new types of motion pictures.

Decision to use standard-width slow-burning film instead of inflammable film in prints.

Exhibition of department films before four large gatherings of department employees in Washington, with a total attendance of 6,000.

Advancement of the plan, with tangible results recorded, under which State agricultural colleges and extension divisions are urged to establish State distribution centers for Department of Agriculture films.

Compilation of results of motion-picture questionnaire among extension agents. These results, in connection with numerous complimentary expressions from other sources, demonstrate the existence of a great field of usefulness for our films, and indicate that Department of Agriculture films are highly regarded.

### LIST OF NEW FILMS.

The new films completed are listed below:

Exit Ascaris. (2 reels, Bureau of Animal Industry.)
Sir Lactius—The Good Milk Knight. (2 reels, Bureau of Animal Industry.)
Dates—America's New Fruit Crop. (1 reel, Bureau of Plant Industry.)
Potatoes—Early and Late. (1 reel, Bureau of Plant Industry.)
Sweet Potatoes from Seed to Storage. (1 reel, Bureau of Plant Industry.)
Bees—How they Live and Work. (1 reel, Bureau of Entomology.)
Keeping Bees at Work. (1 reel, Bureau of Entomology.)
Fighting Western Pine Beetles. (1 reel, Bureau of Entomology.)
An Undesirable Alien. (1 reel, Bureau of Entomology.)
How to Poison Boll Weevils. (1 reel, Bureau of Entomology.)
The Ox Warble—A Fifty-Million-Dollar Tune. (1 reel, Bureau of Entomology.)
Anne's Aigrette. (1 reel, Bureau of Biological Survey.)
National Bird Refuges. (1 reel, Bureau of Biological Survey.)
Mixed Asphalt Pavements. (1 reel, Bureau of Public Roads.)
Building Bituminous Roads. (1 reel, Bureau of Public Roads.)
Brick—From Clay to Pavement. (1 reel, Bureau of Public Roads.)
Highroads and Skyroads. (1 reel, Bureau of Public Roads.)
White Pine—Beautiful and Useful. (1 reel, Bureau of Plant Industry.)
When Elk Come Down. (2 reels, Forest Service.)
When North Winds Blow. (1 reel, Forest Service.)
She's Wild. (1 reel, Forest Service.)

New films practically completed at the end of the fiscal year are:

Pines that Come Back. (1 reel, Forest Service.)
Winter Lumbering in the White Mountains. (1 reel, Forest Service.)
Crops and Kilowatts. (1 reel; Forest Service.)

The Forest Ranger's Day. (1 reel, Forest Service.)
Building a Sand-Hill Forest. (1 reel, Forest Service.)
Guarding Livestock Health. (1 reel, Bureau of Animal Industry.)
Making Poultry Pay. (1 reel, Bureau of Animal Industry.)
Anchored Acres. (1 reel, States Relation Service.)
Fire—The Prairie Demon. (1 reel, Forest Service.)
Around the West by Forest Roads. (1 reel, Bureau of Public Roads.)
Building Forest Roads. (1 reel, Bureau of Public Roads.)
The Golden Fleece. (1 reel, Bureau of Markets and Crop Estimates.)

Films revised during the year—some of them to such an extent that they are practically new pictures—follow:

What about Macadam? (1 reel, Bureau of Public Roads.)
Granite Block Paving. (1 reel, Bureau of Public Roads.)
Great Dairy Sires and Their Daughters. (1 reel, Bureau of Animal Industry.)
Uncle Sam—World Champion Farmer. (1 reel, miscellaneous.)
The Ox Warble—A Fifty-Million-Dollar Tune. (1 reel, Bureau of Entomology.)
Goodbye Boll Weevil. (2 reels, Bureau of Entomology.)
Making the South Tick-Free. (1 reel, Bureau of Animal Industry.)
Charge of the Tick Brigade. (1 reel, Bureau of Animal Industry.)
High Steppers. (1 reel, Bureau of Animal Industry.)
Strawberries—From Seed to Shortcake. (1 reel, Bureau of Plant Industry.)
Future Forest Giants. (1 reel, Forest Service.)

Minor revisions were completed in 10 other films.

### NEW PROJECTS UNDER WAY.

New projects on which considerable work was done include:

The Horse in Motion. (Bureau of Animal Industry.)
Sugar Cane and Cane Sugar. (Bureau of Plant Industry.)
Beets—From Seed to Sugar. (Bureau of Plant Industry.)
Better Ways of Growing Cotton. (Bureau of Plant Industry.)
Peanut Production. (Bureau of Plant Industry.)
White Pine Blister Rust in the West. (Bureau of Plant Industry.)
Cranberry Production and Diseases. (Bureau of Plant Industry.)
Morgan Horses. (Bureau of Animal Industry.)
Bird Banding. (Bureau of Biological Survey.)
Barring Foreign Plant Foes. (Federal Horticultural Board.)
Seeing Washington with Club Champions. (States Relations Service.)
Insecticide Board Work. (Insecticide and Fungicide Board.)
Should I Buy a Tractor? (Bureau of Public Roads.)

Preparatory work, including scenario writing, was done on 15 other subjects not yet approved for production.

### WIDER DISTRIBUTION ATTAINED.

Too often is the "making of a movie" and its release regarded as the end of the enterprise. As a matter of fact, the job is only begun when the film is made ready for showing to the public. Just as in the case of the farmers' crops, without efficient marketing the production counts for little. A film held idle might as well not exist, except for historical purposes. In the past year the task of getting the department pictures shown has met with marked success, and increasingly wider distribution is certain with continued improvement in the quality of the films.

Definite reports from extension workers and others indicate that their film audiences during the year reached a total of at least 2,000,000 people. It should be remembered that a large part of this number would be regarded as specialized. In other words, better results were undoubtedly secured than if the films had been shown to general audiences.

The figures as compiled from the records of the division and from reports made by users, not including an estimate on films for which no reports were made, follow:

| | |
|---|---|
| Film shipments from laboratory during the year | 2,066 |
| Reels included in the shipments | 5,559 |
| People who saw the films, as reported by the users | 1,937,570 |

The number of subjects in distribution at the end of the year was 148, and the number of reels available for distribution from our laboratory was 1,078.

On many films, including the thousand or more that have been purchased by cooperating and outside agencies, the department has no check. It is known that many of these films are being used regularly. If figures were available, undoubtedly the year's audience would reach far above the numbers given above.

Another method of distribution from which no figures are available is provided by the commercial film weeklies or reviews. Several film productions of this nature included scenes from department pictures during the year, and it is probable that through this means several million people were made acquainted with the meaning of some of the work being conducted by the department.

A most encouraging feature of the distribution records is that the State agricultural colleges and extension divisions are beginning to recognize the wisdom of installing film-distribution centers as part of their working equipment. Through this system should come much wider and more efficient use of department films. A number of the State agricultural colleges are included in the list of purchasers of prints of our pictures. This list indicates a number of other interesting facts. During the year 66 purchasers bought 226 prints of 77 separate pictures. Representatives of foreign governments continue to be regular purchasers. Commercial institutions in this country recognize the advantage of cooperating with the department by the use of its films, and are spending money in order to do so.

### BETTER SCENARIOS AND DIRECTION.

A primary essential in the production of a creditable motion picture is a well-constructed scenario, which in most cases can be produced only by a man or woman with literary training and knowledge of motion-picture technique. Another essential is intelligent direction, for which are required the same qualifications and in addition executive ability and understanding of human nature.

Progress has been made during the year in these particulars by the development of the workers and by additions to the staff.

### NEEDS OF THE WORK.

One of the greatest needs—an adequate, well arranged, and healthful laboratory—may soon be filled. If the present hopes for the new laboratory are not realized, another effort for a suitable structure should be made.

Another outstanding need—a very serious one if the personnel is to be maintained—is increased salaries for some of the workers in the office and laboratory.

## ADDRESSING, DUPLICATING, AND MAILING SECTION.

A consolidation of the addressing and duplicating work of the entire department was ordered in the fiscal year 1921, but it was not until the summer of 1921 that the consolidation was finally accomplished, and it was not until January 1, 1922, that the consolidated unit was thoroughly organized.

As a result of the consolidation surplus material and equipment to the approximate value of $20,000 was collected from the various bureaus and turned over by this division to the General Supply Committee after provision was made for the needs of the division for as long ahead as it was possible to see them. The consolidation has been successful in every way, in spite of the difficulties involved in bringing into one organization employees from a number of bureaus. The output of the consolidated unit has been considerably in excess of the total output of the units before the consolidation. The output per machine and per man has been the object of special attention, with the result that there has been an increased efficiency on the part of the various operators. The waste of paper has been cut by careful management from approximately 4 per cent to less than 1 per cent.

Considerable difficulty has been experienced in providing necessary stocks of paper for use in the work. The total amount of paper used is very large, and this division has not had adequate funds to keep sufficient stocks on hand. It became necessary, therefore, to secure the Secretary's authority to call upon bureaus for whom work is done to buy, in advance, paper up to the estimated amount of work to be done and to credit each bureau with this amount after the work has been performed. This method was worked out fairly well and is expected to prove effective during the coming fiscal year. Difficulty was experienced toward the end of the fiscal year in securing paper, but it was possible to obtain stocks of certain needed sizes from other sources than the General Supply Committee and tide over the emergency.

It was expected that the consolidation would result in material saving in the number of people employed on the addressing and duplicating work. Experience has shown, however, that demand in the department for this work is exceedingly heavy and the increased facilities provided by the consolidated section have merely resulted in increasing the output. The section has been called upon to handle an exceedingly large number of jobs, of which 43 per cent have been rush work on which delivery was demanded on the same day the has been performed. This method was worked out fairly well and is satisfactory service under these conditions. A canvass of all bureaus of the department made toward the end of the fiscal year, in which criticisms of the service were invited, failed to uncover a single complaint.

Particular credit is due for the way in which the work involved with the agricultural conference was handled. Employees of the addressing, duplicating, and mailing section on many occasions worked far into the night and on one occasion came down to the office late at night in order to get out publicity material in regard to the progress of the conference. It is also worthy of mention that in establishing the master index of mailing lists the addressograph unit of the addressing, duplicating, and mailing section was able to make a complete run of all the lists in the section in five days without the employment of additional help and without interfering with the routine work of the section.

# REPORT OF THE LIBRARIAN.

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United States Department of Agriculture,
Office of the Librarian.
*Washington, D. C., September 9, 1922.*

Sir: I have the honor to submit herewith the executive report of the library for the fiscal year ended June 30, 1922.

Respectfully,

Claribel R. Barnett,
*Librarian.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

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Considering 1862, the year the department was established, as the date also of the establishment of the library, the fiscal year 1922 is the sixtieth year of the library's existence. The account of the past year's work is taken largely from the reports of the heads of the divisions of the main library and the reports of the bureau librarians. The heads of the main lines of work in the main library are as follows: Miss Emma B. Hawks, assistant librarian, in general charge of reference and bibliographical work and circulation; Miss Helen M. Thompson, chief catalogue and order division; Miss Lydia K. Wilkins, chief periodical division; and Miss Ethel E. Smith, secretary to librarian, in charge of correspondence, files, and personnel records. The names of the librarians of the various bureaus are given on page 4. As the tables appended give a detailed synopsis of the routine work, they will be only briefly summarized here.

## ACCESSIONS.

On July 1, 1922, the library contained 163,391 accessioned books and pamphlets. Of these, there were added by purchase during the year, 1,384 volumes, 81 pamphlets, 464 serials and continuations, and 9 maps. The additions by gift and exchange were 934 volumes, 751 pamphlets, 5,683 continuations, and 59 maps. In addition, 1,305 volumes were added through the binding of periodicals and serials. The total accessions numbered 10,670. The periodicals received currently numbered 3,114, of which 2,169 were received by gift and exchange.

Among the donations to the library special mention should be made of a much valued gift of $150 for the purchase of economic books. This was given to the library by Dr. H. C. Taylor, Chief of the Bureau of Markets and Crop Estimates (now the Bureau of Agricultural Economics), it being the sum which he received for his course in agricultural economics in connection with the series of educational courses conducted under the auspices of the department last year. It is the first gift of money ever received by the library aside from the regular congressional appropriations.

Some progress was made during the year in completing the files of foreign periodicals of the war period. Negotiations were entered into with certain scientific institutions in Germany from whom we are hopeful of receiving a number of missing volumes and numbers in exchange for publications of this country.

The shrinkage in the purchasing power of the library appropriation has seriously hindered acquisition of out-of-print books, the number of those bought during the past year being comparatively small. Perhaps the most important of the acquisitions of the year was Curtis's Botanical Magazine, volumes 66–70 (1840–1844). The volumes are exceptionally rare and have been on our desiderata list for 15 years or more, during which time they have practically never been obtainable save with complete sets of the Botanical Magazine. Another periodical acquired this year which is very little known, and, although less important than the preceding, possibly much more rare, is the "Portefeuille des Horticulteurs" (2 v. Paris, 1847–48), which contains notes of new plants introduced or originated by the Cels and other French growers and importers of that period. Other rarities were Bivort's "Album de Pomologie" (4 v. 1847–1851), one of the most important illustrated fruit books; the "Hortus Ericaeus Woburnensis" (1825); Pfeiffer's "Enumeratio diagnostica Cactacearum" (1837); the "Florae Leydensis Prodronus" (1740) of Adrian van Royen; Allioni's "Stirpium praecipuarum littoris et agri Nicaeensis Enumeratio" (1757); the "Enumeratio Plantarum quae in horto Procopii a Demidoff Moscuae vigent" (1781), by Pallas; one of the mileposts in the history of agriculture, the "Georgica Curiosa" (Nürnberg, 1695) of Hohberg; Pierre Morin's "Remarques necessaires pour la Culture des Fleurs" (1658), regarded as the first floricultural book; "Hortorum Libri XXX," by Benedictus Curtius or Le Court (Lugduni, 1560); "De Drie t'Zamenspraeken tusschen Waermondt en Gaergoedt" (Haarlem, 1734), interesting as a document on the seventeenth century "tulipomania"; "Herbier forestiere de la France," by Eugene de Gayffier (Paris, 1868–1873); and "Genera of birds," by C. R. Gray (London, 1849). The most important entomological work purchased during the year was Seitz, "Die Gross-schmetterlinge der Erde." One other acquisition of the year, although not a purchase, should be mentioned here. The library has for some time been waiting to catalogue an incomplete copy of Jacquin's "Stapeliarum in hortis Vindobonensibus cultarum Descriptiones, etc." (1806), being unable to find any other copy in the United States with which to compare it. However, on learning that the New York Botanical Garden had obtained one during the previous year, arrangements were made to have the missing parts supplied by photostat, so the library has now not only a working copy of its own but has been able to print an authoritative catalogue card for what seems to be one of the rarest of Jacquin's much-sought publications.

Among the notable accessions of a different character should be mentioned an extensive History of the Chicago Board of Trade, by Charles Henry Taylor, in three volumes, and a bound file of the Daily Market Reports of the New York Cotton Exchange, beginning with the year 1900.

A large number of current catalogues and a few old ones were added to the special collection of horticultural trade catalogues. A careful count of the collection which was made during the past year showed that it now contains 18,894 catalogues from the United States and 4,031 foreign catalogues, making a total of 22,925.

## CATALOGUING.

The total number of books and pamphlets fully catalogued during the year was 10,670. In addition, author cards were made for 229 pamphlets of less importance and for 2,745 "reprints." The number of uncatalogued books, pamphlets, and maps at the end of the year was 3,313. The number of cards prepared for printing by the Library of Congress in the "Agr." series was 1,155, of which 369 were for publications of the department and 786 for accessions to the library. There were added to the main dictionary catalogue 17,148 cards and 1,739 were withdrawn, making a net addition of 15,409. The main catalogue now contains approximately 465,000 cards.

## USE OF THE LIBRARY.

The circulation of books was 85,683. The number of periodicals currently circulated was approximately 176,030, making the total recorded circulation 261,713. This indicates only in part the use of the library, as no record is kept of the reference use of the library. Furthermore, statistics of circulation are not kept in all the branch libraries. The number of interlibrary loans to libraries out of the city was 1,148. The number borrowed by this library from other libraries in Washington was 4,028 and from libraries outside of the city 69.

During the month of March the experiment was tried of keeping the library open each week from Monday to Friday until 6 p. m., instead of closing at the regular closing hour for Government offices, 4.30 p. m. The advantage taken of the privilege by department workers did not, however, seem to justify the continuance of the experiment. Possibly during the winter months the privilege would have been more appreciated.

## BUREAU AND DIVISION LIBRARIES.

In the following table are enumerated the various branch libraries in the bureaus and divisions. The statistics, summaries, and extracts which are given in regard to the various libraries are taken from the reports of the librarians. It is regretted that it is impossible, because of lack of space, to give these reports in full. An account of the bibliographical work of the various libraries is given under the heading "Bibliography." Statistics of circulation are included in the table "Combined statistics of circulation" in Appendix 1, on page 12.

*Books, pamphlets, and periodicals in bureau, division, and office libraries.*

| Bureau or office. | Number employed. | Number of books. | Number of pamphlets. | Number of periodicals currently received. | Number of regular borrowers. | Number of regular borrowers to whom periodicals are circulated. |
|---|---|---|---|---|---|---|
| Bureau of Animal Industry, Miss Carrie B. Sherfy, librarian | 3 | 2,600 | [1] 2,800 | 536 | 124 | 122 |
| Animal Husbandry Division, Miss Jessie Urner, librarian | 2 | 2.410 | 5,180 | 165 | 35 | ............ |
| Bureau of Chemistry, Miss Louise Duvall, librarian | 4 | [1] 8,000 | ............ | 415 | 245 | 98 |
| Bureau of Entomology, Miss Mabel Colcord, librarian | 2 | 8,242 | 9,525 | 566 | 141 | 22 |
| Forest Service, Miss Helen M. Stockbridge, librarian | 1 | [4] 23,184 | ............ | [1] 175 | 119 | 62 |
| Bureau of Markets and Crop Estimates,[5] Miss Mary G. Lacy, librarian | 8 | [1] 23,000 | (2) | 1,320 | (2) | [3] 104 |
| Bureau of Plant Industry, Miss Marjorie F. Warner, librarian | 10 | [1] 3,700 | [1] 1,100 | 908 | 2[illegible]0 | 187 |
| Bureau of Public Roads, Miss Orrena L. Evans, librarian | 3 | [1] 1,300 | [1] 5,000 | 251 | 135 | 91 |
| States Relations Service, Miss Martha L. Gericke, librarian | 8 | [1] 3,000 | [1] 8,000 | [1] 800 | [1] 115 | 55 |

[1] Approximate figures.
[2] Figures not available.
[3] Offices.
[4] Books and pamphlets.
[5] After July 1, 1922, called the Bureau of Agricultural Economics.

The work of the libraries of the Bureau of Chemistry, Bureau of Entomology, Forest Service, and States Relations Service was continued along the lines reported in previous years. There were no changes in location or in the organization of the libraries. An additional room was, however, assigned to the States Relations Service library. In the Bureau of Animal Industry library a slight change was made in the organization. The former associate librarian of the bureau was transferred to the main library rolls and her title changed to assistant reference librarian, in charge particularly of the reference work in veterinary medicine. She continued, however, to have her desk in the Bureau of Animal Industry library in order to be in closer touch with those who needed her services. An additional room was assigned during the year to the library of the Bureau of Public Roads, and in November an assistant librarian was appointed. The large increase in the number of books on file in the division of animal husbandry of the Bureau of Animal Industry was due to the fact that approximately a thousand additional herdbooks, for use in connection with the certification of pedigrees, were transferred from the main library.

One of the outstanding events of the year in the activities of the bureau libraries is the reduction in the number of bureau libraries due to the consolidation of the libraries of the office of Farm Management, the Bureau of Crop Estimates, and the Bureau of Markets, following the consolidation of these bureaus. While the consolidation of the Bureau of Crop Estimates with the Bureau of Markets was effective on July 1, 1921, the consolidation of the office of Farm Management with these two bureaus did not become effective until July 1, 1922. When, however, it appeared earlier in the year that legislation authorizing the consolidation in order to form the new

Bureau of Agricultural Economics would be enacted by Congress, plans were made for combining the three libraries and for the reorganization of their work.

The first step toward the consolidation was the combining of the current periodical files and the circulation records of the three libraries. This work was carried out previous to July 1, but owing to the delay in obtaining the new rooms on the third floor of the Bieber Building for the use of the library of the combined bureaus, it was possible to carry out the physical consolidation of the book collections only in part before July 1, 1922. The small collections of the office of Farm Management were merged with those of the Bureau of Markets during the early spring and the librarian of the office moved to the library of the Bureau of Markets and Crop Estimates on May 15, as she had been appointed assistant librarian of the combined bureaus. The library of the former Bureau of Crop Estimates, which was located on the second floor of the main building, could not, however, be moved until after July 1. As the library of the former Bureau of Crop Estimates was one of the largest of the branch libraries, the moving of the collection to the building in which the main library is located is a big step toward carrying out the policy of consolidating the collections in so far as possible. While the collections of these combined bureaus will not be actually incorporated with those of the main library, they will be in close proximity to the main library.

In the death on November 5 of Miss Eunice R. Oberly, librarian of the Bureau of Plant Industry, the library work of the bureau and of the whole department suffered an irreparable loss. She had organized the library of the bureau and had shaped its policy, directed its activities, and year by year made wider opportunities for its service. For six months after her death the affairs of the library were administered by Miss Jessie M. Allen, assistant librarian of the bureau, and on May 16 the position of librarian was filled by the appointment of Miss Marjorie F. Warner, who had been for 19 years at the head of the bibliographical investigations project of the office of Economic and Systematic Botany, a project which for many years past has been in such close cooperation with the bureau library as to form practically a part of it.

The necessity for moving from two of its rooms during the year hampered very considerably the routine work of the Bureau of Plant Industry library. In November it was necessary to vacate the small room used for periodical work and to take in place of it a room on the floor above. Although the change involved little loss in actual space, it required many readjustments of work. In May the library was obliged to give up one of its large rooms to the seed laboratory, which had been moved from the Bieber Building to the west wing. The restricted space left to the library made it impossible for it to carry on all of its former activities. In spite of almost equally crowded conditions in the main library the time seemed favorable for transferring to it some of the routine work as a trial move toward further consolidation and coordination of such work in the interests of economy and efficiency of the whole departmental library service. Accordingly all the records of book charges were transferred to the main library and incorporated with the records of the loan desk. An assistant from the Bureau of Plant Industry library was detailed to the main library temporarily to assist in incorporating the records. All requests from the Bureau of Plant Industry for books are now sent direct to the main library, as no charge records for them are maintained in the Bureau of Plant Industry library. This does away with double charging. At the time the charge records of the Bureau of Plant Industry library were transferred to the main library the collection of books in the bureau library was also considerably reduced by returning a number to the main library. On account of the crowded condition of the shelves of the main library it was not, however, possible for it to take the sets of periodicals which had been filed in the bureau library. Until these sets can be returned to the main library the new plan can not work as well as could be desired. The main library will probably be able some time during the coming winter to care for all the books, as additional space will be provided for the library when the motion-picture laboratory is moved from the basement of the Bieber Building. The possibility is also being considered of maintaining in the main library the records of the circulation of current periodicals to the bureau workers. This would be a logical development of the general plan of centralizing the service functions in the main library, and emphasizing the bibliographical and reference research functions in the bureau libraries.

During the year the librarian of the department prepared for the use of the newly appointed library committee a detailed statement on the centralization of the libraries of the department. The statement is available in typewritten form and may be consulted by any who are interested. The members of the library committee are as follows: Dr. E. D. Ball, director of scientific work, chairman; Karl F. Kellerman, associate chief Bureau of Plant Industry; Dr. W. W. Skinner, assistant chief Bureau of Chemistry; Leon M. Estabrook, associate chief Bureau of Agricultural Economics; Miss Claribel R. Barnett, librarian of the department.

## BIBLIOGRAPHY.

The most important piece of bibliographical work carried on by the main library during the year was in connection with the printing of the list of serials currently received by the library. A list of the current periodicals was prepared in the spring of 1921 and sent to the printer in June, 1921. Later it was decided to enlarge the scope of the bulletin by adding a separate list of the current serials (annual reports, transactions, etc.), combining both the periodical and serial titles in a subject list and a geographical list at the end. As the slips used in the title lists after being printed were rearranged by subjects, and later geographically, it delayed the printing of the bulletin, which is still in press. It is expected from the press in the next month or two. It includes 2,691 periodicals and 2,895 serials. United States Government publications and the publications of the State agricultural colleges and experiment stations are not included in the list.

Two additions were made during the year to the mimeographed series of Bibliographical Contributions of the Library, namely, Nos. 2 and 4. No. 2 is a "Check list of publications of the State agricultural experiment stations on the subject of plant pathology, 1876–1920." This list was prepared in the library of the Bureau of

Plant Industry by Miss Eunice R. Oberly and Miss Jessie M. Allen, being completed by the latter after Miss Oberly's death. It comprises 179 pages and gives a general survey of the work in the various stations on plant pathology as shown in their publications. No. 4 is entitled "Bibliography on the preservation of fruits and vegetables in transit and storage, with annotations." It consists of 76 pages and was prepared in the library of the Bureau of Markets and Crop Estimates by Miss Katharine G. Rice.

Another bibliography in mimeographed form, prepared in the library of the Bureau of Markets and Crop Estimates but not issued in any series, was the second supplement to the Bibliography on the Marketing of Farm Products, bringing it up to date. It consisted of 37 pages and was issued in nine parts, as follows: 1. General. 2. Cotton and cotton seed. 3. Fruits. 4. Vegetables and miscellaneous crops. 5. Grain. 6. Live stock, meat, and wool. 7. Dairy products, poultry, and eggs. 8. Markets. 9. Transportation and storage.

At the time of the National Agricultural Conference in January, 1922, the librarian of the Bureau of Markets and Crop Estimates prepared for the use of one of its committees a brief bibliography on the history, results, etc., of price fixing by governments both in time of peace and war. Later a supplement was prepared on price fixing for wheat and wool in Australia and New Zealand.

An index to current prices, both domestic and foreign, was begun in the library of the Bureau of Markets and Crop Estimates and now covers 1,068 commodities in the United States and 174 in foreign countries. Only 80 periodicals have been examined thus far, but it is hoped that during the coming year it will be possible to include in it practically all of the periodicals received in the department which contain current prices.

In the Bureau of Plant Industry library work was continued on the botanical catalogue, 3,528 cards having been added to the author catalogue and about as many in the subject catalogue. The total number of cards in the catalogue (exclusive of the plant pathology subject) is over 200,000. The current index to botanical illustrations was also kept up.

In the Bureau of Animal Industry library work was continued on the veterinary index and the dairy index. The number of cards added to the veterinary index during the year was 5,015 and 350 were added to the dairy index. On May 1 the veterinary index, which has been a project of the Bureau of Animal Industry for about 20 years and which now comprises about 187,000 cards, was placed under the jurisdiction of the main library in conformity with the general policy of centralizing, in so far as feasible, the bibliographical work of the department. Under present conditions, however, it did not seem feasible or desirable to change the location of the index.

In the Bureau of Entomology library numerous small bibliographical lists on entomological subjects were prepared, and considerable progress was also made on two extensive bibliographical undertakings, namely, (1) a complete list of all entomological publications of the department, and (2) a revision of Bureau of Entomology Bulletin 81, entitled "A List of Works on North American Entomology." Work was also continued on the various catalogues, indexes, and lists maintained by the library which have been described in previous reports.

Attention was called in the report for last year to the fact that no complete list of the current accessions to the library is published, but that the need for information on the resources is partially filled by special subject lists of new accessions to the library which appear in mimeographed publications issued by several of the bureaus. In addition to those mentioned last year, there is now being issued twice a week by the library of the Bureau of Public Roads a mimeographed list of the contents of current periodicals received by the bureau. The monthly list of current forestry literature which for some years past has been issued separately in mimeographed form is now printed in the Journal of Forestry. The first issue to contain the list was the one for March, 1922. The list is prepared by the librarian of the Forest Service. Another means of making known the accessions to the library was presented during the year in connection with the new weekly publication called the Official Record, issued by the department. This publication, which is in the nature of a "house organ," gave an opportunity for the library to include each week a selected list of its more important accessions. It meets the library's needs in some respects perhaps better than a monthly bulletin of accessions, as the Official Record is given a much more extensive distribution than it would probably be possible to give to a library bulletin.

The Daily Digest, which was started last year by the library in cooperation with the press service and the bureaus of the department, was transferred on January 23, 1922, to the jurisdiction of the press service. Because of the close relation between the work of the press service, the Official Record, the Daily Digest, and the clipping service, it seemed desirable to the Secretary's office that those who are engaged in these various activities should have the advantage of closer contact.

## BINDING.

In the report last year mention was made of the resignation of the assistant in charge of the binding and the necessity for her successor, who had had no experience in binding and no previous experience in this library, to take up the work after only a week's instruction under the former chief. This was a severe handicap to the binding work last year. A similar misfortune befell the work this year, as the assistant appointed last year resigned the 1st of November, 1921, to accept a more remunerative position in another library. The work was carried on for six months by one of the assistants in the Periodical Division. On May 15 one of the cataloguers was appointed to take charge of the work. Unfortunately, she was obliged to resign on July 1 because of illness in her family. The outlook for next year, therefore, is also not bright. The interruption to the work during the past year, due to the inexperience of those in charge, came at a particularly unfortunate time on account of the fact that for the first time in several years there were sufficient funds available for binding. In order to make up to some extent for the decrease in the number of books prepared in the early part of the year, due to change in the assistants in charge, three and sometimes four of the cataloguers helped with the collation of the books for the bindery for half of each day during two months. By reason of this fact the number sent to the bindery, namely, 2,856, was a thousand in excess of the number sent last year, but far below the number which needed to be sent, as the current binding has been in arrears for the past three or four years.

## EXCHANGES AND MAILING LISTS.

During the year 1,793 orders (as compared with 1,624 last year) were issued on the Division of Publications for the mailing of department publications which were requested by foreign institutions and officials, and by societies and private individuals from whom publications are received in exchange. The total number of addresses appearing on the foreign mailing lists maintained by the department for exchange purposes is approximately 4,000, in addition to the list of 1,000 addresses to which the Monthly List of Publications of the department is sent. The revision of the mailing lists, which was started during the fiscal year 1921, has been completed and all addresses have been transferred to new mailing-list cards especially designed for the purpose.

## ORDER WORK AND BOOKKEEPING.

The record of the order work and bookkeeping for 1922 as compared with the record for 1921 is as follows: Requisitions issued for periodicals and books in 1921 numbered 1,569; in 1922, 2,060. Requisitions issued for supplies in 1921 were 67; in 1922, 83. Shop requests in 1921 were 132; in 1922, 122. Requisitions for printing and binding numbered 41 in 1921, and 77 in 1922. The vouchers audited for payment in 1921 numbered 956, and in 1922, 1,176. A comparison of the receipts and expenditures of the library for the past 10 years is given in the table in Appendix 10.

## LIBRARY STAFF.

Mention has previously been made in connection with the account of the Bureau of Plant Industry of the irreparable loss suffered in the death of Miss Eunice R. Oberly, who had been librarian since 1908. Her personality and ideals were an inspiration to the staff and aroused in all her associates a spirit of cooperation and a fuller appreciation of library service in the broadest sense.

The resignations and transfers from the bureau libraries during the year numbered seven. Of this number, five were library assistants and two were clerical assistants. Four left the department and the other three were transferred to other offices in the department. Among those who were transferred to other work special mention should be made of Mrs. E. H. Painter, librarian of the former Bureau of Crop Estimates. With the consolidation of this library with the library of the former Bureau of Markets, Mrs. Painter was assigned, at her request, to the statistical work of the combined bureau. Miss Anna Dewees, the former librarian of the Office of Farm Management, was made assistant librarian of the Bureau of Markets and Crop Estimates in the spring of 1922, as the office was to be consolidated with the bureau named to form, on July 1, 1922, the Bureau of Agricultural Economics.

In the main library there were during the year six resignations, three transfers, and one death, that of a messenger boy. Of the nine who resigned or were transferred, three were library assistants, one was an editorial assistant, two were clerical assistants, one was a messenger boy, and two were charwomen. Of the three library assistants who left the library, two resigned to accept more remunerative positions, one in a bureau library and the other in a library outside of Washington. The third, the assistant in charge of the binding, resigned on account of illness in her family. The editor of the Daily Digest and her assistant were transferred to the office of the Assistant Secretary at the time the jurisdiction of the Daily Digest was transferred to the Press Service.

During the first part of the fiscal year the librarian of the agricultural library of the Iowa State College was given a two months' appointment in the main library in accordance with the library's policy of offering temporary appointments whenever possible to librarians or assistants connected with the State agricultural college and experiment station libraries who wish to have experience in this library.

The number of employees carried on the main library staff at the close of the fiscal year was 33. Of this number three were temporary assistants. The number employed by the bureau and office libraries was 41. Of the total number employed in the main library and the bureau and office libraries, 56 are women and 18 are men, divided as follows: Fourteen in administrative work, including the librarian of the department, the heads of divisions in the main library, and the librarians of the bureaus and offices; 24 library assistants; 21 clerical assistants; 13 messengers; and 2 charwomen.

Library staff meetings were held each month throughout the year with the exception of the months of July, August, and November. The subjects and speakers at the various meetings were as follows: Reports on the American Library Association meeting, by members of the library staff; talk by the Secretary of Agriculture; the work of the Smithsonian Institution, by Frederick L. Lewton; bibliographical work in parasitology, by Dr. Albert Hassall of the Bureau of Animal Industry; the literature of agriculture, by Dr. H. C. Taylor, Chief of the Bureau of Markets and Crop Estimates; the work of the Bureau of Entomology, by Dr. L. O. Howard, Chief of the Bureau; the work of the National Research Council, by Dr. C. J. West; discussion of the translating work of the department, by members of the library staff.

The library was represented at the meeting of the American Library Association at Detroit, Mich., in June, 1922, by the librarian of the department and four other members of the library staff and by six representatives from the bureau libraries. The librarian of the Bureau of Public Roads, Miss Orrena L. Evans, served during the year as secretary of the Special Libraries Association; Miss Mary G. Lacy, librarian of the Bureau of Markets and Crop Estimates, served as secretary of the agricultural libraries section of the American Library Association, and the librarian of the department served as second vice president of the American Library Association.

## LIBRARY APPROPRIATION.

The appropriation for the past fiscal year was not only not increased over the previous year but was decreased to the amount of $3,020. This was the severest blow which the library has suffered in many years. Seven positions were dropped from the statutory roll and no provision made for them through an increase in the fund for general expenses. In the emergency it was necessary to ask the help of the bureaus in carrying temporarily the salaries of the assistants which were not provided for on the library roll. The bureaus which were able to do so came to the library's assistance, for they recognized the library's need as their own. Their help is gratefully acknowledged. Without it the service of the library would have been seriously impaired.

As the greatest institution for agricultural work in the world the department can not afford not to have at its disposal the best library resources in the country in its special fields. Our appropriation has been sufficient to enable us to get the most necessary and the more obvious books and periodicals in the various subjects investigated by the department, but it has not been sufficient to specialize to the degree desirable and that is possible in some other scientific libraries More money is needed for the purchase of rare. out-of-print books, for the purchase of special collections when opportunities are offered, for source material in agricultural history and for the completion of files of scientific journals and proceedings. In this connection it must be borne in mind also that opportunities for obtaining sets of valued books and journals are diminishing each year and that the competition for them is keener now than in the past, due to the increased number of special libraries which are acquiring such material. The need, therefore, is urgent for a most substantial increase in the library appropriation in order to make good the arrears in the purchase of books during the past few years and to keep pace with the rapidly increasing volume of scientific literature and with the growth of the department.

On account of the difficulty of obtaining sufficient funds for the library by special appropriation for library purposes, it is believed that it would be advisable for an effort to be made to include in the department appropriation bill a clause which would make it possible for the bureaus to transfer to the library a certain per cent of their appropriations for general expenses. It should not, of course, be obligatory for any bureau to make such a transfer of funds, but it would be desirable to make it possible for it to do so if it were so inclined. This would make it easier for the library to meet emergencies arising (1) from the need of a bureau for expensive reference books for its particular use and (2) from the need of a bureau for an unusual number of books, due to some new line of work which it had undertaken.

## LIBRARY BUILDING.

Additional space is one of the greatest needs of the library. The book shelves are badly crowded and more space is also needed for workrooms for the library staff and for the better accommodation of the readers. Furthermore, to make it possible to carry out the general policy of centralizing the collections in so far as feasible, the bookstacks of the main library will need to be very considerably extended. Plans are now in progress for the removal of the motion-picture laboratory from its rooms in the basement of the Bieber Building. These rooms have been promised to the library when vacated. The stacks which the space will accommodate will relieve the present crowded condition of the library and provide some space for future growth. The removal of the motion-picture laboratory from the Bieber Building will also remove a serious fire hazard for the library. But at the best this additional space for the library can only be regarded as temporary relief and as a makeshift arrangement. It is most important that consideration be given to the imperative need for permanent quarters for the library. The old plans for the administration building, connecting laboratories A and B, contemplated provision for the library on the top floor. The space assigned to the library was scarcely adequate years ago when the plans were made and would now be entirely inadequate. Furthermore, it is not believed that it would be advisable to have the library on the top floor, since it needs to be readily accessible to all offices. A separate building for the library in a central location seems to be the only satisfactory solution. The importance of the library service in the work of the department and the great value of its collections, which it would be impossible to replace, urgently demand an adequate, suitable, fireproof, and permanent building especially designed for library purposes and for the needs of the department. Such a building would give permanency to the library and make it possible to build up its collections with the assurance that they would be preserved for use in future years.

## APPENDIX 1.

*Combined statistics of circulation.*

| Bureau. | Number of books charged. | | | | | | | | Number of periodicals charged. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | To individuals. | | To main library. | | To branch libraries. | | Total. | | | |
| | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 | 1921 | 1922 |
| Main library | 11,775 | 13,254 | ...... | ...... | 29,066 | 29,640 | 40,841 | 42,894 | ...... | ...... |
| Bureau of Animal Industry | 4,404 | 4,043 | 188 | 217 | ...... | ...... | 4,592 | 4,260 | 54,259 | 55,789 |
| Bureau of Chemistry | 7,955 | 7,708 | 591 | 654 | 65 | 87 | 8,611 | 8,340 | 24,562 | 25,839 |
| Bureau of Crop Estimates | 9,260 | (1) | 979 | 698 | 346 | 985 | 10,585 | (1) | [3] 10,000 | [3] 10,000 |
| Bureau of Entomology | 2,259 | 2,448 | 264 | 162 | 134 | 124 | 2,657 | 2,734 | 2,630 | 3,246 |
| Office of Farm Management | 3,145 | (1) | ...... | (1) | ...... | (1) | 3,145 | [2] 1,586 | 11,138 | [2] 5,922 |
| Forest Service | 2,729 | 2,738 | 420 | 457 | 1 | 1 | 3,150 | 3,196 | 7,740 | 7,391 |
| Bureau of Markets and Crop Estimates | ...... | (1) | ...... | (1) | ...... | (1) | 5,067 | 8,078 | (1) | (1) |
| Bureau of Plant Industry | 12,186 | 11,492 | 374 | 400 | 34 | 20 | 12,610 | 11,912 | 54,171 | 55,992 |
| Bureau of Public Roads | 944 | 2,602 | 80 | 66 | 12 | 15 | 1,037 | 2,683 | 9,169 | 11,851 |
| | 54,657 | 44,285 | 2,896 | 2,654 | 29,658 | 30,872 | 92,115 | 85,683 | 173,672 | 176,030 |

[1] Figures not available.
[2] Figures for July 1, 1921, to January, 1922.
[3] Approximate figures.

## APPENDIX 2.

*Circulation statistics of the main library, by months and years, for the fiscal years 1913 to 1922.*

| Month. | 1912-13 | 1913-14 | 1914-15 | 1915-16 | 1916-17 | 1917-18 | 1918-19 | 1919-20 | 1920-21 | 1921-22 |
|---|---|---|---|---|---|---|---|---|---|---|
| July | 2,472 | 2,651 | 3,019 | 3,077 | 2,932 | 3,113 | 2,860 | 2,687 | 2,827 | 3,681 |
| August | 2,269 | 2,083 | 2,567 | 3,285 | 2,883 | 3,027 | 2,616 | 3,216 | 2,867 | 3,152 |
| September | 2,584 | 2,531 | 2,793 | 3,334 | 2,955 | 2,968 | 2,232 | 2,678 | 2,790 | 2,866 |
| October | 3,048 | 3,301 | 3,903 | 4,183 | 4,421 | 3,617 | 2,474 | 3,444 | 3,101 | 3,845 |
| November | 3,152 | 3,232 | 3,352 | 4,439 | 4,409 | 3,462 | 2,684 | 2,981 | 3,381 | 3,650 |
| December | 3,051 | 3,226 | 3,570 | 4,140 | 3,797 | 3,137 | 2,728 | 2,897 | 3,369 | 3,448 |
| January | 4,106 | 4,454 | 4,260 | 4,888 | 4,839 | 4,099 | 3,572 | 3,668 | 3,932 | 3,749 |
| February | 3,403 | 3,618 | 3,638 | 4,715 | 4,625 | 3,603 | 3,830 | 3,346 | 3,481 | 3,773 |
| March | 3,415 | 4,021 | 3,980 | 5,028 | 4,640 | 3,676 | 3,920 | 3,699 | 3,840 | 4,481 |
| April | 3,394 | 3,623 | 3,514 | 4,052 | 3,766 | 3,444 | 3,608 | 3,497 | 4,444 | 3,239 |
| May | 3,148 | 2,951 | 3,072 | 4,136 | 3,616 | 3,531 | 3,327 | 3,103 | 3,326 | 3,319 |
| June | 2,891 | 3,188 | 3,285 | 3,637 | 3,476 | 2,770 | 2,606 | 3,085 | 3,483 | 3,691 |
| Year | 36,933 | 38,879 | 40,953 | 48,914 | 46,339 | 40,447 | 36,457 | 38,301 | 40,841 | 42,849 |

## APPENDIX 3.

### INTERLIBRARY LOANS.

The number of books lent to libraries, institutions, and individuals outside of the city was 1,015. To the total number of books lent should be added 126 photostat copies and 7 typewritten copies of articles requested, making the total use outside of the city 1,148. The statistics of the last ten years, arranged alphabetically by States, are as follows:

*Record of books lent outside of Washington during the fiscal years 1913 to 1922.*

| States, etc. | Fiscal year— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
| Alabama | ........ | 3 | 3 | ........ | 10 | ........ | ........ | 10 | 17 | 5 |
| Arizona | 7 | 6 | 4 | 14 | ........ | 7 | 4 | 4 | 23 | ........ |
| Arkansas | ........ | ........ | 2 | 3 | 4 | 5 | 9 | 19 | 32 | 21 |
| California | 19 | 27 | 26 | 50 | 38 | 13 | 28 | 43 | 16 | 18 |
| Colorado | 9 | 12 | 27 | 24 | 16 | 7 | 5 | 10 | 18 | 9 |
| Connecticut | 16 | 4 | 4 | 2 | 2 | 5 | 1 | 7 | 13 | 5 |
| Delaware | 11 | 18 | 11 | 10 | 6 | 17 | 11 | 30 | 21 | 28 |
| Florida | 27 | 20 | 44 | 21 | 15 | 21 | 17 | 7 | 5 | 13 |
| Georgia | 1 | 14 | 15 | 37 | 24 | 5 | 4 | 6 | 12 | 31 |
| Idaho | 3 | 5 | 9 | 5 | 10 | 6 | 4 | 8 | 1 | 7 |
| Illinois | 6 | 12 | 7 | 66 | 30 | 44 | 49 | 23 | 20 | 17 |
| Indiana | 7 | 7 | 25 | 20 | 13 | 11 | 4 | 13 | 38 | 7 |
| Iowa | 36 | 24 | 63 | 80 | 40 | 52 | 15 | 22 | 72 | 59 |
| Kansas | 8 | 12 | 59 | 71 | 38 | 31 | 41 | 22 | 3 | 23 |
| Kentucky | 6 | 4 | 25 | 7 | 4 | 8 | 13 | 15 | 13 | 30 |
| Louisiana | 5 | 2 | 2 | 10 | 8 | 21 | 9 | 5 | 5 | 15 |
| Maine | 7 | 11 | 8 | 22 | 16 | 10 | 2 | 3 | 1 | ........ |
| Maryland | 12 | 7 | 25 | 28 | 48 | 30 | 10 | 21 | 24 | 17 |
| Massachusetts | 14 | 18 | 36 | 25 | 33 | 22 | 10 | 37 | 16 | 34 |
| Michigan | 37 | 35 | 22 | 37 | 38 | 21 | 9 | 17 | 50 | 24 |
| Minnesota | 2 | 7 | 64 | 78 | 50 | 44 | 63 | 89 | 88 | 44 |
| Mississippi | 4 | 3 | 4 | ........ | 1 | 1 | 1 | ........ | 4 | 2 |
| Missouri | 17 | 19 | 18 | 15 | 19 | 6 | 2 | 10 | 6 | 22 |
| Montana | 15 | 13 | 5 | 15 | 19 | 37 | 17 | 13 | 7 | 6 |
| Nebraska | 32 | 20 | 20 | 18 | 10 | 4 | ........ | 15 | 7 | 7 |
| Nevada | ........ | ........ | ........ | 3 | 1 | 1 | ........ | 1 | ........ | 2 |
| New Hampshire | 8 | 5 | 3 | 2 | 8 | 10 | 7 | 6 | 9 | 11 |
| New Jersey | 1 | 24 | 83 | 53 | 76 | 28 | 42 | 49 | 89 | 63 |
| New Mexico | 1 | 4 | 3 | 9 | 8 | 6 | 7 | 6 | 11 | ........ |
| New York | 59 | 113 | 142 | 127 | 148 | 103 | 66 | 85 | 81 | 117 |
| North Carolina | 35 | 30 | 48 | 17 | 15 | 7 | 1 | 6 | 26 | 43 |
| North Dakota | 6 | 11 | 3 | 11 | 3 | 6 | 6 | 5 | 14 | 10 |
| Ohio | 53 | 103 | 78 | 29 | 41 | 56 | 9 | 30 | 32 | 35 |
| Oklahoma | ........ | 1 | ........ | ........ | ........ | ........ | ........ | 1 | 7 | 8 |
| Oregon | 54 | 44 | 51 | 66 | 51 | 73 | 5 | 19 | 53 | 30 |
| Pennsylvania | 34 | 19 | 21 | 29 | 19 | 21 | 10 | 30 | 51 | 37 |
| Rhode Island | ........ | 1 | 6 | 2 | 17 | 4 | 2 | 12 | 5 | 8 |
| South Carolina | 5 | 1 | 1 | 22 | 27 | 14 | 2 | 2 | 12 | 11 |
| South Dakota | ........ | ........ | 3 | ........ | ........ | ........ | ........ | 3 | ........ | 3 |
| Tennessee | 16 | 26 | 20 | 31 | 22 | 19 | 11 | 10 | 11 | 12 |
| Texas | 10 | 9 | 23 | 11 | 38 | 8 | 9 | 4 | 21 | 14 |
| Utah | ........ | ........ | 8 | 17 | 16 | 8 | 8 | 14 | 19 | 22 |
| Vermont | 27 | 30 | 21 | 9 | 3 | 3 | 10 | 3 | 7 | 12 |
| Virginia | 52 | 54 | 32 | 26 | 18 | 4 | 10 | 19 | 46 | 28 |
| Washington | 3 | 14 | 8 | 11 | 2 | 8 | 21 | 12 | 31 | 4 |
| West Virginia | 10 | 2 | 12 | 16 | 8 | 19 | 19 | 10 | 13 | 15 |
| Wisconsin | 89 | 31 | 38 | 41 | 34 | 36 | 62 | 2 | 48 | 63 |
| Wyoming | 5 | ........ | 4 | 5 | 3 | ........ | 6 | 4 | 6 | 11 |
| Canada | 2 | ........ | 1 | ........ | 1 | 1 | 3 | 1 | 2 | 1 |
| Cuba | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1 |
| Hawaii | 2 | 2 | ........ | ........ | 3 | 2 | 1 | ........ | ........ | ........ |
| Porto Rico | 39 | 67 | 57 | 43 | 39 | 28 | 11 | 14 | 32 | 9 |
| Island of Guam | ........ | ........ | ........ | ........ | ........ | ........ | 2 | 1 | ........ | ........ |
| Alaska | ........ | ........ | ........ | 2 | ........ | ........ | ........ | 1 | ........ | 1 |
| Panama | ........ | 1 | ........ | ........ | ........ | ........ | ........ | ........ | 1 | ........ |
| Total | 826 | 896 | 1,196 | 1,240 | 1,093 | 893 | 658 | 799 | 1,139 | 1,015 |
| Photostat copies of articles | ........ | 47 | 101 | 129 | 168 | 84 | 145 | 142 | 78 | 126 |
| Typewritten copies of articles | ........ | 17 | 12 | 9 | 12 | 11 | ........ | 17 | 11 | 7 |
| | 826 | 960 | 1,309 | 1,378 | 1,273 | 988 | 803 | 958 | 1,228 | 1,148 |

## APPENDIX 4.

*Summarized statement of books borrowed from other libraries during the fiscal years 1913 to 1922.*

| Library from which borrowed. | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|---|---|---|
| Library of Congress | 3,000 | 3,868 | 4,365 | 5,279 | 4,629 | 3,567 | 4,126 | 3,385 | 3,290 | 3,180 |
| Surgeon General's library | 1,056 | 805 | 750 | 939 | 962 | 878 | 607 | 476 | 470 | 511 |
| Smithsonian Institution and National Museum | 138 | 205 | 130 | 227 | 141 | 124 | 110 | 75 | 100 | 68 |
| Geological Survey | 62 | 137 | 101 | 92 | 57 | 49 | 64 | 73 | 61 | 69 |
| Patent Office | 15 | 21 | 19 | 29 | 49 | 25 | 36 | 18 | 20 | 40 |
| Bureau of Education | 29 | 31 | 15 | 43 | 41 | 4 | 11 | 4 | 21 | 22 |
| Public Library | 27 | 29 | 20 | 33 | 11 | 13 | 21 | 10 | 18 | 39 |
| Hygienic Laboratory | 2 | 6 | 3 | 45 | 21 | 15 | 12 | 12 | 3 | 28 |
| Bureau of Standards | 7 | 4 | 2 | 2 | 7 | 2 | 2 | 6 | 8 | 17 |
| Other libraries in Washington | 1,341 | 60 | 56 | 85 | 92 | 40 | 37 | 62 | 86 | 54 |
| Total from libraries in Washington | 5,677 | 5,166 | 5,463 | 6,774 | 6,010 | 4,717 | 5,026 | 4,121 | 4,077 | 4,028 |
| Libraries outside of Washington | 91 | 62 | 58 | 86 | 82 | 35 | 70 | 39 | 58 | 69 |
| Grand total borrowed from other libraries | 5,768 | 5,228 | 5,521 | 6,860 | 6,092 | 4,752 | 5,096 | 4,160 | 4,135 | 4,097 |
| Largest number borrowed on any day | 43 | 40 | 42 | 42 | 41 | 46 | 4 | 30 | 60 | 35 |
| Average number borrowed daily | 18 | 16 | 18 | 23 | 16 | 15 | 16 | 13 | 13 | 13 |
| Largest number borrowed in any month | 731 | 564 | 579 | 734 | 623 | 481 | 613 | 458 | 480 | 436 |
| Average number borrowed monthly | 480 | 432 | 460 | 571 | 507 | 396 | 424 | 346 | 344 | 341 |

## APPENDIX 5.

### ACCESSIONS.

The total number of catalogued books, pamphlets, and maps added to the library during the year was 10,670, an increase of 3,185 as compared with the catalogued accessions of the previous year. Detailed statistics of the accessions of the past five years are given in the following table:

*Accessions to the library for the fiscal years 1913 to 1922.*

| Accessions. | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|---|---|---|
| Purchases: | | | | | | | | | | |
| Volumes | 1,321 | 1,548 | 1,353 | 1,595 | 1,949 | 1,510 | 1,373 | 1,989 | 1,420 | 1,384 |
| Pamphlets | 51 | 41 | 39 | 49 | 76 | 79 | 88 | 119 | 47 | 81 |
| Maps and charts | 1 | 1 | ...... | 13 | 1 | 4 | 2 | 6 | 3 | 9 |
| Serials and continuations | 459 | 511 | 376 | 274 | 147 | 97 | 154 | 187 | 456 | 464 |
| Total | 1,832 | 2,101 | 1,768 | 1,931 | 2,168 | 1,690 | 1,617 | 2,301 | 1,926 | 1,938 |
| Gifts: | | | | | | | | | | |
| Volumes | 886 | 719 | 780 | 873 | 641 | 676 | 647 | 768 | 774 | 934 |
| Pamphlets | 830 | 470 | 500 | 397 | 508 | 642 | 371 | 580 | 492 | 751 |
| Maps and charts | 28 | 20 | 22 | 18 | 4 | 59 | 15 | 21 | 10 | 59 |
| Continuations | 4,425 | 4,490 | 4,909 | 4,919 | 4,458 | 3,807 | 2,647 | 4,762 | 3,515 | 5,683 |
| Total | 6,169 | 5,699 | 6,211 | 6,207 | 5,611 | 5,184 | 3,680 | 6,131 | 4,791 | 7,427 |
| From binding periodicals and serials | 1,573 | 1,826 | 1,085 | 1,612 | 1,178 | 949 | 748 | 1,161 | 768 | 1,305 |
| Total | 9,574 | 9,626 | 9,064 | 9,750 | 8,957 | 7,823 | 6,045 | 9,593 | 7,485 | 10,670 |

According to the record of accessions the total number of books and pamphlets accessioned by the library up to July 1, 1922, was 170,057. From this number should be taken 5,910 which were discarded during the fiscal year 1915 and 756 which were discarded in the last seven fiscal years, leaving a balance of 163,391 accessioned volumes and pamphlets in the library on July 1, 1922.

## APPENDIX 6.

### CATALOGUING.

The record of the material catalogued during the past five years is as follows:

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Volumes | 2,186 | 2,020 | 2,757 | 2,194 | 2,318 |
| Pamphlets | 721 | 459 | 699 | 539 | 832 |
| Maps | 63 | 17 | 27 | 13 | 68 |
| Serials and continuations | 4,853 | 3,549 | 6,110 | 3,971 | 7,452 |
| Total | 7,823 | 6,045 | 9,593 | 7,485 | 10,670 |
| Pamphlets[1] | 570 | 273 | 501 | 96 | 229 |
| "Reprints"[2] | 945 | 2,498 | 1,937 | 4,828 | 2,745 |

[1] Not fully catalogued. [2] Author cards only.

*Uncatalogued material.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Volumes | 41 | 368 | 274 | 290 | 543 |
| Pamphlets | 178 | 648 | 599 | 1,085 | 1,905 |
| Continuations | 190 | 943 | 540 | 1,105 | 846 |
| Maps | 2 | 6 | 7 | ......... | 19 |

*Number of titles prepared for printing by the Library of Congress in the "Agr." series.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Cards for accessions and recatalogued books | 483 | 512 | 817 | 1,097 | 786 |
| Cards for department publications | 577 | 656 | 611 | 627 | 369 |
| Total | 1,060 | 1,168 | 1,438 | 1,724 | 1,155 |

*Record of cards added to the catalogue.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Number of cards added | 26,229 | 21,881 | 21,504 | 23,730 | 17,148 |
| Number of cards withdrawn | 3,846 | 3,118 | 2,353 | 4,244 | 1,739 |
| Net addition to catalogue | 22,383 | 18,763 | 19,151 | 19,506 | 15,409 |

## APPENDIX 7.

*Periodicals.*

| | |
|---|---|
| Number of different periodicals currently received by purchase | 945 |
| Number of different periodicals currently received by gift and exchange | 2,169 |
| Total number of different periodicals received | 3,114 |
| Number of additional copies purchased | 240 |
| Number of additional copies received by gift and exchange | 238 |
| Total number of periodicals purchased, including duplicates | 1,185 |
| Total number of periodicals received by gift and exchange, including duplicates | 2,407 |
| Grand total of periodicals received currently, including duplicates | 3,592 |

The average number of current periodicals received daily during April and May, 1922, was 302. The average number received during the same period in 1921 was 268. The average number received during the same period in 1920 was 249.

| | |
|---|---|
| Number of other serials (such as annual reports, proceedings, etc. received currently, exclusive of Government publications and the publications of the State agricultural colleges and experiment stations | 2,895 |

## APPENDIX 8.

*Binding.*

| | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|
| Number of books sent to the bindery | 1,674 | 2,019 | 1,866 | 1,821 | 2,858 |
| Number of volumes placed in temporary binders | 1,675 | 1,612 | 1,000 | 1,152 | 1,059 |
| Pamphlets stapled in binders | 1,443 | 743 | 984 | 622 | 675 |

Approximately 10,000 current numbers of periodicals, bulletins, and reports were also added to the files already in temporary binders. These consisted principally of department and State experiment station publications, the files of which are placed in temporary binders until a sufficient number has been received for permanent binding.

## APPENDIX 9.

*Expenditures for Library printing and binding for the fiscal years 1919, 1920, 1921, and 1922.*

| Item. | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|
| Regular binding | $2,734.23 | $8,255.30 | $5,537.74 | [1] $12,723.58 |
| Binders | 1,641.23 | 606.84 | 1,151.12 | (2) |
| Pamphlet boxes | 330.00 | | | |
| Forms | 247.82 | 259.38 | 241.64 | 303.26 |
| Publications | 400.36 | 84.30 | 94.61 | 889.17 |
| Index cards | | | | 578.27 |
| Miscellaneous | 4.57 | 4.88 | 6.09 | 55.31 |
| Total | 5,358.21 | 9,210.70 | 7,031.20 | 14,549.59 |

[1] Includes regular binding and binders

[2] Separate figures not available Included with regular binding.

## APPENDIX 10.

*Financial statement, fiscal years 1913 to 1922.*

RECEIPTS.

| | Fiscal year. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
| Source: | | | | | | | | | | |
| Library appropriation | $41,280.00 | $43,520.00 | $45,360.00 | $46,020.00 | $49,520.00 | $50,160.00 | $50,160.00 | $50,160.00 | $54,880.00 | $51,460.00 |
| From department printing and binding fund | 13,843.31 | 11,345.84 | 10,190.62 | 9,662.12 | 8,707.52 | 12,068.38 | 5,358.21 | 9,210.70 | 7,031.20 | 14,549.59 |
| Total | 55,123.31 | 54,865.84 | 55,550.62 | 55,682.12 | 58,227.52 | 62,228.38 | 55,518.21 | 59,370.70 | 61,911.20 | 66,009.59 |

EXPENDITURES.

| | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 |
|---|---|---|---|---|---|---|---|---|---|---|
| Books and serials | $6,791.73 | $9,083.69 | $8,300.90 | $8,840.89 | $8,975.89 | $7,257.40 | $7,186.86 | $9,246.05 | $9,310.67 | $9,376.17 |
| Periodicals | 3,625.42 | 4,233.41 | 3,586.17 | 3,978.46 | 4,093.62 | 4,252.62 | 6,139.99 | 5,231.48 | 5,924.90 | 6,080.03 |
| Maps | | 47.50 | .40 | | 215.00 | 40.88 | .70 | 62.04 | | |
| Index cards | 215.86 | 174.03 | 194.88 | 169.59 | 129.07 | 78.86 | 85.25 | 112.23 | 178.51 | 141.88 |
| Furniture, shelving, and miscellaneous equipment | 2,635.99 | 769.37 | 3,148.23 | 866.85 | 552.26 | 765.88 | 604.04 | 293.16 | 2,525.94 | 29.91 |
| Traveling expenses | 38.45 | | | 31.20 | | | 179.44 | 48.52 | 219.72 | 139.18 |
| Freight, express, and drayage | | | | | 10.62 | 16.24 | 37.75 | 93.07 | 56.94 | 54.10 |
| Supplies and repairs | 313.27 | 323.42 | 350.00 | 429.16 | 469.21 | 981.33 | 609.01 | 539.58 | 518.50 | 565.10 |
| Truck service | | | | | | | | | | 10.38 |
| Salaries (main library) | 27,100.27 | 28,377.29 | 29,585.50 | 31,278.06 | 33,025.53 | 33,272.25 | 31,440.95 | 31,462.85 | 29,934.60 | 33,990.63 |
| Total | 40,723.99 | 43,008.71 | 45,166.08 | 47,237.54 | 47,471.23 | 46,665.58 | 46,283.99 | 47,088.98 | 48,669.78 | 50,387.38 |
| Printing | 4,084.21 | 1,892.25 | 1,895.47 | 1,806.79 | 1,727.17 | 1,576.78 | 652.75 | 348.56 | 342.34 | 1,826.01 |
| Binding | 9,759.10 | 9,453.59 | 8,295.15 | 7,855.33 | 6,980.35 | 10,491.60 | 4,705.46 | 8,862.14 | 6,688.86 | 12,723.58 |
| Total | 13,843.31 | 11,345.84 | 10,190.62 | 9,662.12 | 8,707.52 | 12,068.38 | 5,358.21 | 9,210.70 | 7.031.20 | 14,549.59 |
| Grand total | 54,567.30 | 54,354.55 | 55,356.70 | 56,899.66 | 56,178.75 | 58,733.96 | 51,642.20 | 56,299.68 | 55,700.98 | 64.936.97 |

# REPORT OF THE DIRECTOR OF THE STATES RELATIONS SERVICE.

UNITED STATES DEPARTMENT OF AGRICULTURE,
STATES RELATIONS SERVICE,
*Washington, D. C., September 8, 1922.*

SIR: I have the honor to present herewith the report of the States Relations Service for the fiscal year ended June 30, 1922.

Respectfully,

A. C. TRUE, *Director.*

HON. HENRY C. WALLACE,
*Secretary of Agriculture.*

## INTRODUCTION.

### FUNDS ADMINISTERED.

During the fiscal year 1921–22 the force carried on the rolls of the had administrative and advisory relations in the expenditure of $14,027,300, of which $8,927,300 were Federal funds. In addition, the agricultural colleges and experiment stations used, in experimental and extension enterprises, $11,600,000 derived from sources within the States. The Federal funds included $1,440,000 appropriated for the agricultural experiment stations under the Hatch and Adams Acts; $4,080,000 for cooperative extension work under the Smith-Lever Act; and a supplementary appropriation of $1,500,000 to be expended under the terms of that act; $1,350,520 for farmers' cooperative demonstration work; and other funds appropriated for the work of the service amounting to $556,780. State funds amounting to $5,100,000 were used as an offset to the Federal funds for extension work as required by law.

### PERSONNEL.

During the year ended June 30, 1922, the States Relations Service States Relations Service was approximately 4,000. The number of counties having county agricultural agents increased to 2,100, and the number having home demonstration agents increased from 700 to 800. The total force employed at the Washington offices decreased from 290 to 265.

### DUTIES AND ORGANIZATION OF THE SERVICE.

In general, the States Relations Service represents the Secretary of Agriculture in his relations with the State agricultural colleges and experiment stations, under the acts of Congress granting funds to those institutions for agricultural experiment stations and cooperative extension work in agriculture and home economics, and in carrying out the provisions of the acts of Congress making appropriations to the Department of Agriculture for farmers' cooperative demonstration work; investigations relating to agricultural schools, farmers' institutes, and home economics; and the maintenance of agricultural experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands.

The service has included the following offices: (1) Office of the Director, which deals with the general business and administration of the service and the work relating to agricultural instruction and farmers' institutes; (2) Office of Experiment Stations, which deals with the work and expenditures of the State and insular experiment stations; (3) Office of Extension Work, which deals with cooperative extension work in agriculture and home economics in the 48 States; and (4) Office of Home Economics, which carries on investigations relating to food, clothing, and household equipment and management.

## OFFICE OF THE DIRECTOR.

The general administrative business of the States Relations Service connected with appointments, accounts, supplies, and the preparation and dissemination of publications and illustrative material continued to be large in amount and to cover a great variety of subjects involved in the work of the agricultural experiment stations and extension divisions of the agricultural colleges. As a clearing house regarding the organization, activities, and publications of agricultural institutions throughout the world, the service is called upon to an increased extent for information through correspondence, conferences, and publications.

### EDITORIAL DIVISION.

W. H. Beal, *Chief.*

The business of the service relating to publications, job printing, illustrative material, publicity, and duplicating was handled through the Editorial Division as heretofore.

Publications.—The publications of the service were both technical and popular.

The technical publications summarized the literature and progress of agricultural investigation in this country and abroad; reported in detail the results of experiments and investigations by the experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, and explained their local application in developing improved farm practices; reviewed the work of the State experiment stations and discussed questions arising in connection with the administrative and advisory relations of the department thereto; recorded progress in the organization and conduct of the various lines of cooperative extension work in agriculture and home economics; and reported the results of investigations in home economics.

The popular publications dealt with such subjects as the selection of food with reference to body needs, the food of farm families, the food value of milk, home canning, kitchen planning, floors and floor coverings, and the practical advantages of home demonstration and boys' and girls' club work.

There were printed for the States Relations Service during the year 55 documents aggregating 3,458 pages, as follows: 21 numbers of Experiment Station Record, including 2 index numbers; 3 administrative reports, including the report of the director of the States Relations Service, 1921, work and expenditures of agricultural experiment stations, 1919, and cooperative extension work in agriculture and home economics, 1920; 11 publications of the experiment stations in Alaska and the insular possessions, including reports of the Alaska, Hawaii, Porto Rico, and Guam experiment stations for 1920, 1 bulletin of the Hawaii station, 1 bulletin and 2 circulars of the Porto Rico station, 1 bulletin and 1 circular of the Guam station, and 1 bulletin of the Virgin Islands station; 2 department bulletins dealing respectively with food selection and heat production of honeybees in winter; 7 department circulars dealing respectively with county agent, home demonstration, and boys' and girls' club work, extension work among negroes, statistics of cooperative extension work, the paper dress form, and kitchen planning; 4 farmers' bulletins dealing respectively with milk as food, home canning of fruits and vegetables, floors and floor coverings, and food requirements of the average family; 3 Yearbook articles dealing respectively with the diet of rural homes, home demonstration work in the South, and the influence of boys' and girls' club work on community life.

An article on the assimilation of nitrogen, phosphorus, and potassium by corn, contributed by the Porto Rico station, was printed in the Journal of Agricultural Research, and about 20 articles relating to various features of the work of the service were published in outside journals.

About 45 orders for job printing and binding were handled during the year.

The larger part of the duplicating work formerly done by this division was transferred during the year to the Division of Publications, a small unit only being retained to take care of the more urgent current work of the service.

The division cooperated with the Press Service of the department in assembling and preparing articles relating to the work of the service for press release and the Official Record. About 500 such articles were contributed by the service during the year. A consistent and timely program to serve as a guide in preparing material of this kind was worked out. As a basis for this program a complete outline of suitable subjects for publicity was made in cooperation with the various offices of the service, supplemented by a calendar of such subjects as required seasonal treatment. With this outline and calendar as a guide, it has been possible to make the material more timely and to keep it more closely in accord with the actual work and the needs and interests of the service.

ILLUSTRATIONS SECTION.—The work of this section in cooperation with other offices of the service and other bureaus of the department was materially increased during the year along the lines of securing photographs illustrating the work of the service and its cooperating agencies; preparing lantern slides and distributing them to extension workers and agricultural teachers; cooperating in the preparation of motion pictures relating to extension work; assembling exhibits of the work of the service; and giving instruction to field workers cooperating with the service in the preparation and use of illustrative material.

Seven States (Iowa, Minnesota, South Dakota, Wisconsin, Maryland, North Carolina, and Virginia) were visited by a representative of the division to secure carefully planned series of photographs illustrating extension work with farm boys and girls, agricultural school work, and work of the State experiment stations. There were added to the collection of photographs relating to agriculture and home economics available for the use of employees and cooperators of the service 1,598 prints, making the total number of photographs now in the collection 16,408, of which 13,758 are mounted, classified, and catalogued.

Thirteen series of lantern slides were prepared for distribution to extension workers and agricultural teachers illustrating camp activities for club members, culling poultry, furnishing and decorating bedrooms, pork production, judging sheep, watermelon diseases, varieties of chickens, community buildings, labor-saving methods and machinery for harvesting and haying, strawberry culture, standardization of fruits and vegetables, agricultural school buildings and equipment, and vocational work in agriculture in negro schools. Eight other series were nearly completed. During the year 1,076 sets of 40 or more slides each were distributed for the various offices of the service.

A total of 4,555 lantern slides, 143 bromide enlargements, and 51 transparencies were colored, and 356 charts, drawings, and designs were made in the section. In addition, the photographic laboratory of the Division of Publications made for the service 2,940 negatives, 11,647 prints, 8,952 slides, and 540 miscellaneous items, including 40 blue prints.

The section cooperated in preparing outlines for two motion-picture films relating to extension work. About 1,700 requests from extension workers and rural schools for loan of department films were handled through the section.

In addition to giving field employees of the service information and assistance in the preparation of exhibit material relating to their work, the section cooperated with the Office of Exhibits in the preparation of material for two interstate boys' and girls' club-work exhibits—at Springfield, Mass., and Sioux City, Iowa—and for a joint exhibit of the department and the State agricultural colleges and experiment stations at the Brazilian Centennial Exposition.

At the request of State extension services and State departments of education, short talks and demonstrations were given in methods of extension photography and the preparation and use of illustrative material by a representative of the section at conferences in 10 States—Connecticut, Rhode Island, New Hampshire, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Alabama, and Florida.

### INVESTIGATIONS ON AGRICULTURAL INSTRUCTION IN SCHOOLS.

E. H. SHINN, *Chief Specialist in Agricultural Education.*

Studies were continued during the year to determine improved methods and the content of subject matter for the use of teachers of agriculture in secondary and elementary schools. Progress in the development of vocational agricultural education, together with the increased interest in prevocational education in agriculture, has stimulated the demand for material useful to teachers of agriculture, and it has been the aim of this division to make available to teachers and students of agriculture useful material derived from the large amount of agricultural information constantly being accumulated by the Department of Agriculture and the agricultural colleges and experiment stations. The teaching of agriculture below college grade is a comparatively new thing in the United States, but since the passage of the vocational education act much greater interest is being manifested in this work. Teachers of agriculture are being better trained for their duties through the teacher-training divisions established in connection with the State agricultural colleges. This new movement is accompanied by greater demand for knowledge of the latest methods of instruction and other information useful to these teachers. With the cooperation of the subject-matter specialist of the different bureaus of the department, much up-to-date information is being made available to agricultural teachers.

Cooperative relationships are at present maintained with the following agencies outside the Department of Agriculture: (1) With the Federal Board for Vocational Education in the preparation of publications for the use of teachers of agriculture in high schools which receive aid through the vocational education act; (2) with certain States which desire to have prepared special outlined courses of study in agriculture for the rural schools; (3) with teacher-training divisions in the States by supplying helpful publications, by conferences, by correspondence, and by loaning illustrative material; and (4) with teachers in service by supplying publications and other information for use in the schools, making suggestions as to the use of such material, and loaning lantern slides prepared especially for the use of agricultural teachers.

In cooperation with the Federal Board for Vocational Education further study was made of job analysis of certain farm enterprises in the production and marketing of agricultural commodities. The unit course in poultry husbandry was revised as a result of suggestions received in conference with teachers in service and with heads of teacher-training divisions. Publications were prepared for use in the vocational agricultural schools operating under the Smith-Hughes Act on the following subjects: Analyzing the poultry enterprise, analyzing the swine enterprise, and analyzing the potato enterprise. Much favorable comment has been received from teachers in service and from teacher-training divisions in the States on these publications.

In continuation of cooperation with the State of North Carolina in the preparation of a course of study in elementary agriculture, conferences were held during the year with the State superintendent of public instruction and with members of the staff of the college of agriculture of North Carolina regarding the course. Visits were made to the summer normal schools at Asheville, Durham, Raleigh, Wake Forest, Chapel Hill, and Greensboro to confer with rural teachers on the use of this course of study. Cooperation is now in progress with the States of Oklahoma and Utah in the preparation of similar courses of study for those States.

The State courses of study in elementary agriculture and other publications of the division have been used in normal schools offering courses for rural teachers. There have been numerous requests from teacher-training divisions for the classified lists of department publications, agricultural texts, and other lists of material prepared by the division for the use of agricultural teachers.

Teachers of agriculture are realizing more and more the advantage of using farmers' bulletins and department bulletins giving up-to-date information along certain lines. By cooperating with teachers in service the division supplies large numbers of teachers with lists of those publications of the department best adapted to their needs, with suggestions as to their use. Teachers are also realizing the value of such publications in the hands of pupils as supplements to the regular textbooks.

In the preparation of suggestive outlines for the use of teachers it is recognized that the successful teaching of agriculture in a community must have a vital connection with the farm problems of that community. Pupils are naturally interested in those things with which they come in daily contact, and the type of agriculture practiced in a community can be used to the best advantage in teaching agriculture. Teachers are therefore offered suggestions and urged to organize the subject matter which is of interest to the community and to teach the subject in the concrete rather than the abstract, to give seasonal application to topics when practicable, and to make the program of work in the school touch as closely as possible the life and experiences of the pupils.

The demand from agricultural teachers for illustrative material increased rapidly during the year, and large numbers of teachers were supplied with lantern slides. In the new sets which are being prepared from time to time special attention is given to adapting the material to the needs of those teachers who realize the value of illustrative material in teaching agriculture. Plans are under way to increase the supply of such material available for distribution. In cooperation with the Division of Publications, a number of motion-picture films were lent to agricultural teachers.

Representatives of the division attended and took part in annual conferences of State supervisors, State directors, and teacher-trainers for vocational education in the Southern, North Atlantic, Middle Western, and Western States. At these meetings conferences were held with individual teachers regarding the practical value of the publications prepared for their use. Suggestions were received as to how cooperation might be carried on more effectively with agricultural teachers. Representatives of the division also attended annual State conferences of agricultural teachers in New Jersey, Massachusetts, and Virginia and at the annual meeting of the agricultural section of the State teachers' association of Wisconsin discussed problems relating to the preparation of coures of study and methods of teaching agriculture in elementary and secondary schools. A member of the staff held conferences with members of the college staffs and officials of the State departments of education in Oklahoma and Utah in regard to final arrangements for the preparation of courses of study in agriculture for the rural schools of those States. Following these conferences preliminary surveys were made in rural sections of those States in company with county superintendents of schools to observe and study typical rural-school conditions.

At the request of State supervisors of agriculture, a specialist was sent to State conferences of agricultural teachers in New Jersey, Massachusetts, and Virginia to talk to teachers on the preparation and use of good pictures and the value of such material to agricultural teachers

In cooperation with the Federal agent for negro vocational schools, and with teachers in these schools, a set of lantern slides showing the development of negro vocational work was made available, and the slides are being used extensively by negro teachers. Studies were made, in cooperation with teachers of vocational agriculture, looking to the preparation of sets of lantern slides based on conditions which show successive steps in the development of competency in the poultry and swine enterprises.

A representative of the division served with representatives of the Federal Board for Vocational Education and the United States Bureau of Education on an advisory committee making studies in regard to the curricula of the land-grant colleges for colored people, and later attended a conference called by the United States Commissioner of Education at Nashville, Tenn., February 13 and 14, 1922, for the purpose of discussing the results of these studies and investigations. The conference was composed of both white and negro people interested in negro education, and included presidents and members of boards of white and negro land-grant colleges, State superintendents of education, Federal and State supervisors of agriculture, teachers of agriculture, and negro extension workers. Most of the time of the conference was given to discussions regarding proposed changes in the agricultural curricula in the negro colleges, minimum standards and equipment, minimum qualifications of teachers, and the improvement of teachers.

Definite recommendations were made in regard to courses in agriculture for high schools. It was agreed that high-school courses should be differentiated from college courses given in the land-grant colleges. Collegiate courses in these subjects were outlined and standards for such courses recommended. It was agreed that colleges having less than five teachers in agriculture holding the bachelors' degree in agriculture should not grant degrees. The director of the service served on a committee on the agricultural curriculum for the senior college and also addressed the conference on "The need for strong vocational institutions for the education of the negro."

As a means of giving further encouragement and assistance to negro agricultural education, visits were made during the year by the director of the service to the negro agricultural and mechanical colleges in North Carolina, South Carolina, Georgia, and Virginia, to Tuskegee Normal and Industrial Institute, Alabama, and to Hampton Normal and Agricultural Institute, Virginia, where data were collected in regard to buildings and equipment, number of students in agricultural classes, and the number of teachers in the agricultural divisions. Conferences were held with teachers for the purpose of discussing methods of stimulating greater interest among colored people in the study of agriculture.

The division continued to review and abstract literature on agricultural education for Experiment Station Record.

Cooperation with the Association of Land-Grant Colleges was continued through its committee on instruction in agriculture, home economics, and mechanic arts, of which the director of the service is chairman. The committee made a report on improvement of college teaching in vocational subjects with special reference to difficulties in doing good teaching, opportunities afforded and means employed to improve teaching and to keep teachers up-to-date in vocational practice, the basis for the promotion of teachers, and the relation of college teaching to research, extension work, and outside employment.

### INVESTIGATIONS ON FARMERS' INSTITUTES.

J. M. STEDMAN, *Farmers' Institute Specialist.*

Farmers' institutes during the fiscal year ended June 30, 1922, were officially in charge of the State government in 15 States, while in the remaining 33 States they were in charge of the extension division of the agricultural colleges. A total of 31 States conducted farmers' institutes during the year. The combined reports of 28 of these States showed a total of 4,616 institutes which lasted 6,253 days, comprised 10,464 sessions, had an attendance of 1,263,339, employed 1,137 lecturers, and cost $267,650.84.

During the fiscal year Pennsylvania transferred its farmers' institute activities from the State department of agriculture to the extension division of the State college, while Kentucky, which did likewise a few years ago, reversed the control of its farmers' institutes, and Texas failed to make an appropriation for them.

Notes on the progress of agricultural extension work in foreign countries have been mimeographed each six months and sent to the leaders in extension work in each State.

The work relating to farmers' institutes and the foreign extension services has recently been transferred to the Office of Extension Work.

## OFFICE OF EXPERIMENT STATIONS.

E. W. ALLEN, *Chief.*

In connection with the administrative relations maintained by the Office of Experiment Stations with the State experiment stations, special stress has been laid the past year on the subject of adequate local administration and the development of more advanced methods and procedure in the study of common problems. These are not new considerations, but their present importance is emphasized by their relation to the growth and efficiency of the experiment stations. Leadership, organization, and increasing intensity of attack are essential to the steady advance of these institutions to higher positions of usefulness.

The provision of proper administrative supervision for the individual experiment station is a matter of fundamental importance. It relates not only to the more or less routine business of the station and the general direction of current work but to the nature of the program developed and to planning for the future. The determination of practical lines to be selected for study, out of the multitude of questions which might be taken up, and the critical examination of the progress of these, together with a looking ahead to anticipate the needs of investigation, are matters essential to good administration and to the framing of a wise policy. Comparatively few stations have reached the point where a very permanent, established policy has become recognized, and not all of them have made the broad survey upon which the determination of such a course would properly rest. In large part their course is contingent on circumstances which vary from time to time and on the attitude of the college from which, or through which, their local support comes. The position of the station in the institution, its relationships, and its individuality are matters not yet beyond the realm of discussion and uncertainty.

Administration relates also to the presentation of the needs and claims of research, in order that it may attain its proper place and be encouraged by the maintenance of conditions which are essential to it. Without proper emphasis on its interests, it is in danger of receiving secondary consideration in the pressure from other branches of the institution; and the fact that the interests of those responsible for its welfare have often become divided and associated with more rapidly growing features may be in part responsible for the hard ways upon which many of the stations have fallen in the past few years.

The condition has so impressed itself upon the office that special attention has been given to pressing the interests of the stations and urging the consideration for their affairs which the situation merits. A considerable number of the stations now have funds amounting, with the Federal contributions, to $50,000, $75,000, and even $100,000. The wise direction of a research institution with a budget of $50,000 to $100,000 a year is no light task, and so much depends upon the outcome in advancing the interests of all other branches of agricultural work that a large measure of responsibility attaches to it.

Special attention has also been given to emphasizing the need of an advanced point of view in devising means of attacking some of the complex questions which have long been the subject of experiment. It is far easier to follow along beaten paths which represent little change in attitude and little advance in the character of the inquiry than to develop new viewpoints and means of attack.

In some lines the broad conception of intricate problems continues as the basis for experimentation, instead of a closer analysis of them, with the narrowing of the special points to be studied and the employment of more intensive methods. Problems and methods have, therefore, become conventionalized to a considerable extent, as applied particularly to certain of the more common practical questions of agriculture. While such work gives results which are not without local interest, it contributes but little to the advancement of principles and broad truths beyond what is already known. In some cases it verges on the field of extension and demonstration. The situation reflects a tendency in some directions to overemphasize empirical methods and to underestimate the importance of determining fundamental laws.

The office has definitely called in question the competence of such broad and vague conceptions of leading questions in agriculture and the ability of conventional methods and procedure to further advance reliable knowledge of them. It has directed attention to the limitations of such methods and to the necessity for originality in developing theory and means of approach. These matters have received attention in connection with the starting of new projects, as well as in the examination of those under way. Insistence has been placed on greater definiteness in projects, their limitation in scope, and the employment of more searching methods. At the present stage of investigation, there is less excuse than formerly for broad proposals which do not exhibit a specific aim and a considered method of attack. Projects of wide range and generic character are discouraged. A clearer insight into the real nature of broad problems is one of the products of the accumulated work of the past, and an interpretation of this background in the building of more advanced inquiry upon it is a measure of advance.

The amount of such advanced inquiry, representing not only a changed viewpoint and critical attitude but the employment of more highly specialized methods, is a noticeable product of recent years, and there is a growing tendency in this direction among leading investigators. This is seen not only as the most promising means of scientific advancement but as ultimately giving highly practical results.

### RELATIONS WITH THE STATIONS.

The dealing with research under Federal funds in accordance with the prescribed laws requires the exercise of tact, sympathy, and a clear appreciation of conditions represented at different institutions over the country. It can not be reduced to a simple formula or set of rules. The stations are a series of individual institutions and require individual attention. Success in aiding them and in influencing the course of their development calls for the maintenance of confidence and relations of amity. The close relations which have been maintained with the individual stations of the system and with their workers have contributed to such mutual understanding. Whatever success has been attained is attributed to the recognition of this common interest and the desire to stimulate and assist in a constructive way.

There is no attempt at direction or control of research or of the lines it takes, but the purpose is to insure that it is headed right, is well considered at the outset, does not stop with repetition either of itself or of other work, and does not continue after it has ceased to mark progress in results or suggestion. The guiding purpose is to bring about favorable conditions for research, to stimulate investigators to their best efforts, to offer suggestion where it may be helpful, and to make the whole effort as effective as possible, viewed as a national system—for the Federal Government and the individual States are in partnership in this enterprise.

It is usually difficult to draw definite lines between what is done under the State funds and what is done under Federal support. The interest of the Federal Government is not confined to its contributions toward the maintenance of individual stations. It is not merely attempting to subsidize research in the States. Its interest extends to the point of developing favorable conditions to insure not only the proper use of the Federal funds but the employment of all available resources for research. This view is expressed in the Hatch Act, whose purpose was "to aid" in the establishment and maintenance of experiment stations; and that this aid was not designed to be limited to the financial contributions is evidenced by provision for the relation of the department with respect to methods and results, the indication of important lines of inquiry, and the furnishing of "such advice and assistance as will best promote the purpose of this act."

In accordance with previous procedure, each of the experiment stations was visited by a representative of the office during the year, its work and expenditures under the Federal funds examined in detail, and conferences held with the administrative head and the workers regarding the general progress and policy of the station. A revision of the classified list of projects carried on by all the stations was prepared and issued and the compilation for a further revision to cover the year 1921 was completed. The latter showed a total of 4,770 station projects, an average of about 95 per station. Of this number 52 were administrative and regulatory, leaving 4,718 relating to research and experimentation. Of the latter 506 were conducted under the Adams fund. This is an average of 10 projects per station, a number which would be far too large, considering the character of the investigations, were it not for the fact that Federal support is supplemented from State sources. Some disposition is found to assign more projects to the Adams fund than can be properly supported. Attempt has been made to check this tendency and to insure the assignment of sufficient funds from that source or from State funds to meet the needs of active and aggressive investigation. Adams-fund projects, which it is found are not making progress or are not receiving active attention, have, under the influence of the recommendations made, been transferred to other funds or temporarily discontinued. Every effort is exerted to make the work under that research fund active, progressive, and on a high plane of investigation; and similarly, with relation to the Hatch fund, care has been exercised that it should stand for substantial experimentation and investigation of a type clearly distinguished from demonstration.

The publication of the projects of all the stations has relieved the tendency toward duplication, and the annual visits to the stations have enabled bringing into association those who were working on similar lines. This has been done without betraying confidences or disclosing methods and results but by the establishment of contacts between workers having similar interests.

### COOPERATION.

During the year a comprehensive review was made of the extent and nature of the cooperation between the Federal Department of Agriculture and the State experiment stations. This is the first attempt at such a complete summary and study of cooperative relationships. It shows these relationships to be continental in scope and discloses the many points of contact between the department and the stations in the States.

The types of undertakings involved in these cooperative relationships with the stations include soil and other surveys; experiments in the methods of production, culture, fertilizer requirements, and adaptation of a long list of agricultural crops, fruits, and vegetables; the study of diseases and pests of cultivated crops, forest trees, and products, their eradication and control; the breeding and improvement of plants and live stock: the study of animal diseases and the maintenance of quarantines and other repressive measures. It embraces studies in farm management and in the cost of production of staple crops under a wide variety of conditions; dry-land agriculture, drainage, and irrigation: the utilization of cut-over and waste land; the factors affecting the carrying capacity of western ranges; life history and food habits of rodents and other injurious animals; and forest reproduction and management.

In fact, there is hardly a branch of agricultural inquiry in which there is not some form of cooperation, and the amount of money involved aggregates many hundreds of thousands of dollars. Altogether there are 140 different cooperative projects and, since many of these are participated in by several stations, the total number of cases of cooperation between the department and the experiment stations amounts to 274. It is worthy of note that this represents over 70 per cent of the cases of cooperation of the department with outside agencies in research.

The review of the results of this type of activity, which has been steadily on the increase, is illustrative of the advantage of such cooperative relations, of its practicability, and of the importance of giving even greater attention to systematizing the conduct of agricultural investigation and avoiding unnecessary and unrelated duplication. The work of the department and the stations is so vast and so varied that it is beyond the ability of any single agency to compass. To prevent its being fragmentary and disjointed, systematized effort on a national basis is highly important. The establishment of close relations, with cooperation in planning and execution, minimizes a tendency to collect local facts without broad interpretation. It leads to greater uniformity of effort, which enables the results to be more readily fitted together and harmonized, and it enables making the attack more comprehensive and complete.

Experience of the recent past has shown that this type of effort need not suppress originality of thought or pride of accomplishment, if proper consideration is shown for each party to the enterprise, with liberality in making the plan and in the ultimate awarding of credit. The ends of cooperation and coordination would be favored by provision for systematic attention to newly establish cooperative ventures and the maintenance of such files relating to them as would make information about them readily accessible.

## EXPERIMENT STATION RECORD.

During the fiscal year Experiment Station Record completed its forty-sixth volume and its thirty-second year of service. Publication during the most of this long period has been carried on without interruption under the general authority given the Secretary of Agriculture to disseminate information and the injunction carried in the Hatch Act to furnish such advice and assistance to the experiment stations as would best promote the purpose of that act. In 1919, however, legislation was adopted by Congress requiring the discontinuance at the close of its next regular session of all Government periodicals not specifically authorized by law. The time limit thus fixed expired June 5, 1920, but was extended by subsequent legislation, first, to June 30, 1921, and then to December 1, 1921. On the latter date no remedial action had been completed by Congress, and publication of the Record along with about 40 other periodicals was suspended. This suspension continued in the case of the Record about one month. Early in January, 1922, following a certification by the Secretary of Agriculture that the matter contained in the Record "is published as administrative information required for the proper transaction of the public business," arrangements were made whereby its publication was resumed. On May 11, 1922, a joint resolution was signed by the President repealing the previous legislation and stating that hereafter "the head of any executive department, independent office, or establishment of the Government is hereby authorized, with the approval of the Director of the Budget, to use from the appropriations available for printing and binding such sums as may be necessary for the printing of journals, periodicals, and similar publications as he shall certify in writing to be necessary in the transaction of the public business required by law of such department, office, or establishment." The passage of this legislation is expected to put an end to the uncertainties of the past three years.

The two volumes of the Record completed during the year contained 7,248 abstracts, besides the customary editorials and notes dealing with the progress of agricultural education and research in this country and abroad. The experiences of the year brought out many favorable comments from users of the Record as to its value and its unique position as a work of reference. With a view to increasing its usefulness in this direction, steps are being taken to prepare another combined index of the Record. No such index has been issued since volume 25, over 10 years ago, and it is hoped to bridge over this period by a third general-index volume.

## DIVISION OF INSULAR STATIONS.

WALTER H. EVANS, *Chief.*

The Federal agricultural experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands of the United States were administered, as heretofore, by the Division of Insular Stations. The accounts of these stations are reviewed in this division and audited in the bureau accounting office.

The projects of all of the stations were reviewed during the year. Some lines of work have been suspended temporarily and the efforts of the stations concentrated on those that appeared to be the most urgent. All the stations continue to work for the diversification of the agriculture of their respective territories.

A number of changes took place in the personnel of the stations, and this caused some modification in the lines of work. So far as possible the vacated positions have been filled, and where that has not been done other members of the staff are carrying the work to the best of their ability. There are fundamental problems at each station that are waiting investigation, but they can not be taken up with the present organizations. Additional funds are needed at each of the stations to properly man the institutions and to make use of the facilities and equipment now on hand.

There is not one of the stations that does not need additional investigators, and in Hawaii and Porto Rico, where stations are maintained by sugar interests, supplemented in the case of Porto Rico by insular support, the prestige of the Federal stations is suffering on account of their inability to compete for men to carry on important lines of work. The Hawaiian station has lost not less than six of its workers during the last three years to the Hawaiian Sugar Planters' Station or to pineapple interests or other concerns. All of these men received largely increased salaries in their new positions. This situation, together with the isolation of the stations, is having a detrimental effect on the morale of the station workers, and it should be corrected as quickly as possible.

The entire resources of the stations are derived from appropriations made by Congress, and for the fiscal year 1922 they were: Alaska, $75,000; Hawaii, $50,000; Porto Rico, $50,000; Guam, $15,000; and the Virgin Islands, $20,000. These sums have not been changed since the appropriation act of 1920, except in the case of the Guam station, where a reduction of $10,000 was made. During the year just passed the stations deposited in the United States Treasury, as miscellaneous receipts from the sale of products, $5,529.58. Under the present law this sum is no longer available to the stations for their support. Prior to 1916 the stations were permitted to retain for their use the sums derived from the sale of their products, and they were largely used in the erection of necessary buildings and keeping others in good repair.

The insufficiency of funds has resulted in the depreciation of some of the earlier buildings so that there is urgent need of buildings and repairs at a number of the stations. The situation is acute at the Fairbanks station in Alaska and at the Guam station. At the Fairbanks station the buildings constructed in 1907 of unseasoned logs are falling into decay, and a new office and residence for the superintendent is badly needed. In Guam the station is situated 5 miles from the town of Agana and has but one residence. The lack of suitable quarters for other members of the staff is a serious drawback, as there are no houses available except in Agana and no regular means of transportation between there and the station.

## ALASKA STATIONS.

The Alaska stations suffered a severe loss during the year in the death of F. E. Rader, who had been in charge of the Matanuska station from its beginning. He was succeeded by B. L. Schneider, who was formerly his assistant in the work. C. S. Hahn, in charge of the Rampart station, resigned late in the fiscal year.

The work of the stations has made satisfactory progress considering their limited resources. The spring of 1922 was quite backward along the southeastern coast, but after seasonable weather arrived all crops grew remarkably well.

At Sitka the work with hybrid strawberries was considerably extended, and there are now about 2,000 hybrid plants under test. A considerable number of these were obtained by crossing some of the earlier hybrids. Many of these new crosses proved to be not winter hardy, as the "wild blood" of the native species was reduced to one-fourth instead of one-half, as in all of the earlier hybrids. Other crosses were made, using pollen from first generation hybrids on the pistils of well-known cultivated varieties. These, too, were injured by winter freezing to a considerable extent. As a result of this experience, it was concluded best to return to the earlier method of hybridizing, and a large number of crosses were made, using the pollen of the wild species, particularly *Fragaria platypetala*, on selected mother plants. Among the newer hybrids many bore their first crop this season, and some very promising fruits were obtained. Among the older hybrids some of the best are being allowed to set runners, and plants of these varieties will soon be ready for extended distribution.

Considerable progress is being made in the potato-breeding work. In the fall of 1921 selections were made of the most promising of the varieties that have been grown from seed collected from seed balls that had been open-fertilized and also from a number that were crossed. Among these selections were a number that showed considerable superiority over the original strains, and these have been planted in plats of 10 hills each in order to secure material for wide tests throughout the Territory. In the spring of 1922, 170 new seedlings that had been grown in flats were added to the field trials. The other experiments at the Sitka station are progressing very well. The station sent out its usual supplies of seeds, plants, rooted cuttings, etc., and for many localities this constitutes the only source of supply.

The development of the Matanuska station is progressing as rapidly as possible. The barn, silo, and root cellar have been so far completed as to be in use, and it is expected that they will be finished during the coming season. The milking Shorthorn cattle again went through the winter in good condition, and the young cows give promise of being very good milk producers. Six head of young Galloways from the Kodiak herd were wintered at the Matanuska station. Three of the heifers had calves which, on account of lack of feed at the station, were sold locally. There is an urgent need for more cleared land to furnish pasture and on which to produce feed for the rapidly increasing herds.

During the season of 1921 more than 1,000 bushels of grain were threshed in the vicinity of the Matanuska station. In the spring of 1922, seeding was finished at the station by May 25, and many of the crops were beginning to come up. A dry June retarded growth somewhat, but later rains have assured good crops. A large variety of small grains, including many of the hybrid grains developed at the Rampart station, was seeded this spring. Of 29 varieties of spring grain tested last year, some of the hybrids gave indication of being well adapted to the region. With a single exception, all the varieties introduced from Canada proved failures. Grimm alfalfa has survived the winter thus far at the Matanuska station.

In 1921 all early maturing grains ripened at the Fairbanks station, although the frost-free period was but 95 days instead of an average of 108 days. In the vicinity of the station there were nearly 6,000 bushels of grain produced, 3,516 bushels of which was wheat, the most of it being Siberian No. 1. A hybrid wheat, produced by crossing Siberian No. 1 with Marquis, ripened in 93 days, and the hybrid seems to possess superior agronomic and milling qualities. Some of the varieties of wheat under test ripened in 83 days. It is expected that much of the grain-breeding work, formerly carried on at Rampart, will be transferred to the Fairbanks station as soon as a readjustment of the work can be effected. The former superintendent of the Rampart station is now in charge of the Fairbanks station, and it is expected that grain hybridization will be conducted on a more extensive scale than formerly. The early indications for 1922 were quite favorable for good crops, especially for some of the newer hybrids.

The live stock at the Fairbanks station came through the winter in good condition. The station now has among its breeding stock milking Shorthorn cattle, a pair of yak, Hampshire pigs, and Toggenburg goats. A Galloway bull and two heifers from the Kodiak herd have been added to the stock at the Fairbanks station, and the long-deferred experiment in crossing the yak and domesticated cattle has been begun. Reciprocal crosses will be made in an attempt to develop a hardy beef animal for the interior of Alaska.

The work at the Rampart station has been curtailed to a considerable extent to permit of more rapid development of the Fairbanks and Matanuska stations. The work with Siberian alfalfa, native vetch, and some grains will be continued. In 1921 65 pounds of Siberian alfalfa seed were produced. The area devoted to this crop is being extended as rapidly as possible in order to produce seed for wide distribution throughout the Territory.

At the Kodiak station the outstanding event of the year was the acquisition, by Executive order, of additional land adjacent to the station. This will permit of considerable extension in the area of pastures and cultivated land. The herd at Kodiak now consists of 30 head, a few purebred Holsteins and Galloways, and about 20 crossbred animals. Some of the crossbred heifers have borne calves which represent the second generation of an attempt to produce a hardy milk cow for the country. The milking qualities of the dams are being investigated.

## HAWAII STATION.

In its effort to bring about a further diversification of the agriculture of the islands the station during the year gave all possible assistance to the development of a starch-producing industry, the utilization of surplus products, development of new and improved forage crops, fruits, and vegetables, studies of the fertilizer requirements of bananas and pineapples, and the use of brackish water for the irrigation of certain crops. The last-mentioned investigations are being carried on so as to insure as large a use of all available water supplies as possible, particularly where the development of additional water supplies does not seem possible.

The activities of the horticulturist have centered on the acquisition of improved fruits and vegetables through introduction from other countries and breeding work carried on with established varieties. When the superiority of the new forms is definitely demonstrated, the improved varieties are propagated for distribution, and during the past year more than 20,000 plants of improved or promising strains were distributed for a wide trial throughout the territory. There is some evidence of the extension of the banana industry, and the station has secured 26 varieties which are being tested in comparison with the Chinese and Bluefields varieties, the only ones that are now grown commercially. Papaya investigations have been continued, and a method has been developed for producing lateral branches that can be removed and rooted as cuttings. A number of very satisfactory strains have been produced and given wide distribution. The use of papaya fruit for combining with pineapple in the manufacture of food products has created a large demand for this fruit, and special attention is given to soil and other requirements of the plant. Variety tests of citrus fruits are being continued, and several hundred seedling trees, grafted to a select Kona orange, are being tested cooperatively by a number of growers. The work with mangoes, avocados, and other fruits is continuing as formerly. A number of valuable varieties have been found, and some of them appear to be distinct horticultural acquisitions. Experiments with coconuts have shown that germination could be hastened by cutting off a part of the stem end of the husk and burying the greater part of the nut in moist rice hulls.

The work of the agronomist is concerned mainly with root crops and forage plants. Among root crops, experiments have been begun with some oriental root crops, such as arrowhead, and with the water chestnut. Several forage plants new to Hawaii were tested during the year, among them Guatemala grass (*Tripsacum laxum*), *Exophorus unisetus*, four varieties of sorghum, and various leguminous crops. The latter were tested not only for forage but also as green-manure crops. The importance of green-manure crops to be grown in connection with pineapple production is becoming well recognized, and special experiments have been begun along this line. A hybrid between the Guam white corn and a variety of sweet corn has been developed that promises to be valuable under Hawaiian conditions where common sweet corn does not flourish. Definite progress is reported in the production of a yellow strain of Guam corn that will meet the common preference for a yellow corn.

On account of quarantine regulations prohibiting the export of all fresh fruits except pineapples and bananas, experiments in the utilization of surplus stocks have been in progress for some time, and the chemist has devised methods for the manufacture of marketable products of a number of Hawaiian fruits and vegetables. In connection with increased banana growing, fertilizer experiments with this crop have been begun, particular attention being given to the times and methods of making the applications. Experience having indicated that pineapples are best grown in rotation with some other crop, a study of systems of cropping was made, and upland sugar cane appeared to be one of the most promising crops to be grown in such a rotation. As a result, a series of fertilizer trials for both crops has been begun to find the best practices to be adopted so as to secure maximum results with each crop. A rather common belief among certain classes is that Hawaiian-grown vegetables are deficient in mineral salts, especially in lime and iron. A preliminary study of the subject failed to substantiate this idea, but in order to obtain definite data on it several common vegetables from the same lot of seed are being grown in two places on the mainland and two in Hawaii, and when ready for marketing they will be analyzed to determine any differences that may be due to soils and climate.

A study of the water used in irrigating various crops has been begun. In many places the only available supplies carry a noticeable amount of salt, and the effect of brackish water on various crops is being investigated. It has already been found that well-established alfalfa plants will tolerate a much greater amount of salt in irrigation water than plants in the seedling stage. The effect of the gradual accumulation of salt on soils and plant life in general is also being studied.

The extension work carried on by the station has undergone some readjustment due to the resignation of F. E. Krauss, superintendent of extension, who had directed this work for seven years. The experimental and demonstration work at Haiku, Maui, was also terminated, as the land on which the work was conducted belonged to the superintendent, and his removal from the locality made it advisable to cease operations on the former scale. Most of the projects undertaken were brought to a satisfactory conclusion and reported upon. A few of the projects are being continued in cooperation with the new managers of the farm, but most of the work needing further confirmation has been transferred to the Haleakala substation, a tract provided by the Territory, but managed by the station. This new substation is about 7 miles from Haiku, and at a somewhat higher elevation, but it represents a large tract of homestead land that had been recently opened for settlement on the island of Maui. Cool nights and the lack of well-distributed rains make profitable agricultural production rather difficult, and the question of first importance to be determined is the crops adapted to the region. About 30 different kinds of crops were under trial during the past year, and pigeon peas, purple vetch, Bellingham peas, and emmer gave the best promise of regular dependable crops. The region in question is a typical grazing one. In fact, it was so used before being made a homestead tract, and it is possible that stock raising will continue to be an important factor in its agricultural development.

The extension agent for Hawaii has continued to give all his time to that island, and he has established valuable contacts with settlers, corporations, and others interested in developing various phases of Hawaiian agriculture. A large ranch in Hawaii has set aside a tract of 10 acres for demonstration work under the direction of the extension agent. The manager of the ranch furnished all implements, work animals, and labor necessary to carry on the work. The home demonstration work begun last year has been continued on a part-time basis. Demonstrations in various phases of household economy were made in cooperation with the Social Welfare Bureau, the average attendance of women at the meetings being 48. In cooperation with the Housewives League of Honolulu, monthly demonstrations were given on the utilization of meats, vegetables, and fruits of the islands. The attendance at these meeting has run as high as 100, most of the women present being of American parentage. At the request of a plantation a demonstration was made with papayas and tomatoes. The attendance at each demonstration was 48 children and 7 adults, although the meetings were intended primarily for girls and boys of the seventh and eighth grades.

### PORTO RICO STATION.

The results of the efforts of the station to aid in improving and diversifying the agriculture of the island are becoming quite apparent. Following the fall in the price of sugar, there has been some reduction in the acreage devoted to that crop, and other industries are beginning to receive considerable attention.

The station continued its activity in breeding up its herd of dairy cows. During the year a fine Guernsey bull was added to the herd. The object lesson given by the station in producing high-grade cows through the introduction of purebred sires is beginning to have an effect, and with the cooperation of the station a number of purebred animals have been recently introduced into the island. The eradication of the cattle tick is necessary before the wide introduction of improved stock can be recommended, and a sentiment for tick eradication is being rapidly developed. There are now more than 100 public and private dipping vats on the island, and many individual plantations have been cleared of ticks, but until there is universal dipping throughout the island there will be danger of reinfestation through work oxen which traverse infested areas. The station tank has been made available for use in the neighborhood and during the year just closed 1,329 head of cattle were treated in it.

The entomologist continued his studies on the life history of the cattle tick in order to secure data that will explain the apparent seasonal differences in the starvation period of the tick. New sets of ticks are started every month, and five years' data have been accumulated regarding their behavior. Investigations on insect transmission of the mosaic disease of sugar cane were continued, and leaf hoppers, plant lice, and other cane insects were transferred from infested canes to healthy ones. A considerable number of insects from weeds and grasses occurring in cane fields also were transferred to cane, but no infections were found either when transferred from diseased cane or from other plants. A study of the relation of certain insects, especially purple scale and cockroaches, to the breaking down of grapefruit in transit and storage was begun. When stored under dry conditions considerable losses occurred, but in the case of grapefruit held under moist or humid conditions, entomogenous fungi destroyed the scale insects, and fruit picked May 6, 1921, was held for 11 months in moist coconut fiber without impairment of quality. An experiment on the control of citrus scab by the use of a Bordeaux-mixture oil spray was begun. The work was undertaken in cooperation with one of the largest growers of grapefruit in the island, and the results of the first season's work were so conclusive that two other groves are now being handled in the same manner. Additional data are being secured regarding the flowering period of the more important honey-producing plants of Porto Rico. When completed these data will be of service in determining the proper procedure for handling bees.

The chemists continued their studies of the nitrogen economy of cane soils. No important differences were noted in yield as a result of applying nitrogenous fertilizers to the experimental plats aside from a greater tendency on the part of the cane plants to lodge. The sucrose and purity of juice were lowest in canes grown on plats that received ammonium sulphate. A study was begun on the effect of fertilizers on some of the disorders of the rice plant, and evidence was obtained that is believed to indicate that the so-called "straight head" disease of rice is caused by an excessive use of nitrogenous fertilizers on poorly drained or unaerated soils. Analyses are in progress to determine the differences in composition of normal and diseased rice plants.

Variety testing and selection work with beans is being continued by the horticulturist. Marked differences in adaptability have been noted, and some superior strains have been secured by selection. Some white strains have been developed in crosses with a black bean from Venezuela that are exceedingly promising. These have been carried through several generations, and studies made of the seed of progeny of this cross are said to show that black color is dominant over white and glossiness of seed coat over dullness. Extension work with root crops is in progress. With sweet potatoes, the variety Key West again showed itself to be the most prolific of the 36 varieties under test. The value of stakes upon which yam vines can climb was again demonstrated, staked plants yielding 41 per cent more roots than unstaked vines. Spacing tests with yautias and taro indicate higher production for yautias when spaced 3 by 3 feet and taro when planted 3 by 3½ feet apart. The coconut fertilizer experiment begun in 1912 is beginning to show definite results. The plats which received salt have yielded four times as many nuts as the check plats. In the coffee fertilizer experiments some very pronounced effects are being shown. The experimental work with vanilla was discontinued on account of a serious root disease. Three commercial vanilla plantings in different parts of the island have been made as a result of the station's work on this crop.

The plant-breeding work is making satisfactory progress. Ear-to-row plantings of corn have shown yields varying from 33.4 to 51.2 bushels per acre. Additional work on the production of suitable table corn is in progress, and $F_1$ and $F_2$ generations of crosses are under observation. A cross between Henderson's sugar corn and a native white field corn has been made, and the $F_3$ generation is now growing. Additional nursery testing of various Porto Rican and introduced rices have resulted in the elimination of many varieties. There are now being tested 42 varieties, 10 of which were found growing in Porto Rico. A larger test is desirable, but irrigation facilities are lacking for larger plats. A test of Honduras rice grown as an upland crop yielded 1,301 pounds per acre. Tests of various cowpeas and soy beans are in progress, and wide variability is shown. A cross has been made between the New York Improved eggplant and a native variety, and the $F_1$ generation was grown during the past season. The fruit is intermediate in size and shape, and the color is so diluted as to show the color pattern of the native variety. Seed has been saved for the $F_2$ generation.

The 1919 sugar-cane seedlings were harvested, and five were found to possess sufficient merit to warrant further testing. About 150 additional seedlings were grown at the station during the past year. Bud selection work with Java 36 and Kavangire was continued. Plantings of Indian wheats and a number of other varieties received from the United States Department of Agriculture were almost complete failures. First, second, and third generation crosses of tomatoes have been grown and some very promising selections obtained. With melons, the $F_3$ generation of crosses of the native muskmelon with several introduced sorts were grown, and a fourth generation is now being produced in the field. Selections of Chamaluco bananas resistant to the Panama disease show more vigorous plants than check unselected lots.

The farm-management specialist has made a study of some of the factors which affect the price of citrus fruit, the data being collected in Porto Rico, New York City, and on vessels carrying the fruit to the latter city. Some work was begun on the shipment of tropical fruits other than citrus fruits and pineapples, but little progress has been made thus far. Work was begun on some pineapple projects, particularly to find the reason for the apparent deterioration of the Red Spanish variety grown for some time in Porto Rico, and also the reason for the apparent soil exhaustion by the pineapple crop. The farm-management office continues to send out extension notes and to cooperate in training and advising agricultural agents for the insular government.

### GUAM STATION.

On account of the reduced income of the station, the work of the past year was seriously handicapped. The agronomist and the extension agent resigned and their places have not been filled. This has left but one scientifically trained man—the animal husbandman—at the station, and he attends to all the lines of investigation as far as it is possible for him to do so. The station is poorly equipped for economical management on account of a lack of suitable work animals, implements, and machinery. This necessitates a large amount of hand labor, and under the conditions existing in the Tropics a large amount of such labor must be employed throughout the year. Again, on account of the limited area of the station proper and the impossibility of securing additional land near by, much of the work with the live stock, especially that with cattle, is carried on at Cotot, some 10 miles away. No reduction in the number of breeding animals has been made as yet, but as no new pastures were planted it will probably be necessary to sacrifice some of the stock within the year. The agronomy work has been reduced to rather small plats, as there was no one to supervise more extended plantings. The horticultural work was confined to caring for the orchards and other plantings, little effort being made to increase the collections or to extend the investigations.

The work on upbreeding the various classes of live stock was continued as far as possible. The former practice of keeping native brood mares at the station for breeding had to be abandoned owing to a lack of labor and pastures. A lack of funds making it impossible to purchase concentrates, the horse-feeding experiments to determine the suitability of copra-meal cake as a part of the ration for horses have been suspended. The station's efforts to upbreed the local native cattle were continued. Two of the better grade bulls were placed in outlying portions of the island for breeding purposes. The station's purebred sires, which were imported in 1920, continued to make good development and 18 privately owned cows were bred to them during the year. Eight grade bulls were disposed of to the public for breeding purposes. Some progress is reported in arousing an interest for the control of cattle ticks. An experiment in the use of supplements for pasture and green feeds was begun, using as far as possible grains and other feeds of local production. The results showed decided gains in weight of animals and in milk production where small amounts of concentrates were fed.

The improvement work with swine is progressing satisfactorily. A feeding experiment with mature hogs showed that a ration of two parts cooked breadfruit, one part damaged rice, and one part copra meal, supplemented by a daily feed of 3 or 4 ounces of tankage, formed a very satisfactory ration for mature animals. The practicability of this ration for growing pigs is now under test. The work with poultry consisted in maintaining a purebred flock of Rhode Island Reds and in the development of a new variety which is the result of crossing a strain of native white hens and Rhode Island Red cockerels. In the second generation some very good white feathered fowls have been obtained, and there has been no decrease in size or vigor over the first generation. Among the crosses of both the first and second generations a number of individuals have been secured that show considerable improvement over those raised during the first year of the experiment. The hardiness of the native fowls is maintained in this new strain. Among the purebred flock considerable improvement in egg laying is noted. For the proper continuation of this experiment the station is in need of additional equipment and new houses and runs.

The station is the only agency in Guam for the distribution of breeding stock, and the demand for improved animals continues to be greatly in excess of the supply that can be furnished with the present facilities.

On account of its close relationship with live-stock improvement, considerable attention continues to be given to the growing of forage plants. Comparative yields of green forage were obtained for three cuttings of various forage grasses. The average yields per cutting were: Napier grass, 56.67 tons; Guatemala grass, 35.5 tons; *Pennisetum setosum*, 14.55 tons; Guinea grass, 13.5 tons; Sudan grass, 5.92 tons; and Japanese cane, 67.2 tons per acre. Tests were made of the relative palatability, 10 cattle and 3 horses being used, the animals being given free choice of the forage. The different grasses rank in apparent palatability as follows: Para grass, Guatemala grass, Japanese cane, and Napier grass. Where the amount of grass consumed in 24 hours was considered, the relative rank was Guatemala grass, Para grass, Japanese cane, and Napier grass.

Experiments with rice have shown the desirability of early planting to escape the ravages of the rice bug and that the application of commercial fertilizers was followed by increased yields. Partly to reduce labor costs of maintenance and to gain information regarding the efficiency of various species of leguminous plants for maintaining a cover for the ground, the entire fruit orchard was prepared and sown to various cover crops during the year.

The grassland soils of Guam, when newly brought under cultivation, almost invariably yield poor returns. To find means of correcting this, a number of experiments have been undertaken, among them pot experiments in liming, which have now been run through five crop periods. Those pots which received an application of lime at the beginning of the experiments and crop residues since that time are showing the beneficial effect of the application of the lime. The horticultural work with tropical fruits has been confined to keeping the trees in as good condition as possible.

Through the cooperation of the insular government the station continued to distribute seeds, plants, and cuttings of various vegetables, economic plants, field crops, forage plants, etc. There was a reduced demand for vegetable and field-crop seeds, indicating, it is believed, that the suggestions of the station regarding the saving and storage of seed are being gradually adopted.

The extension work suffered from reduced appropriations. The agent in charge of this work resigned in November, 1921. An effort was made to continue the work along the original lines, but changes in the district school teachers, who act as supervisors, and the employment of many of the club members seriously hampered the work. Work during the year was carried on with 11 school gardens, represented by 203 workers and with 234 members of the United States Garden Army. Among them garden vegetables were produced to the value of $498.51. In the club work a total of 1,994 boys and girls were enrolled, 1,072 of whom completed the year's program and submitted reports of their work. Products valued at $13,743.54 were raised by these boys and girls.

### VIRGIN ISLANDS STATION.

The agronomist in charge at the Virgin Islands Station, Longfield Smith, resigned early in the fiscal year and was succeeded by John B. Thompson, who was in charge of the Guam Experiment Station for several years. The new station residence, begun in 1921, was completed, and there are now satisfactory housing facilities for the agronomist in charge and the entomologist. Some needed repairs to other buildings were completed and eave troughs were provided so as to increase to 3,000 square feet the area from which water is collected for the station. This is the only water supply for the station. Several acres of brush land were cleared to provide additional pasture for the stock.

Agriculture in the Virgin Islands has been experiencing a period of pronounced depression, due to the low price of sugar and a protracted period of light rainfalls and labor difficulties on the sugar plantations. The last two factors have influenced the station's work to a considerable extent. The rainfall in 1920 was 35.801 inches;

in 1921, 33.72 inches; and for the first half of 1922 it was only 12.7 inches. The normal rainfall, based on 60 years' records, is 46.81 inches. The deficient rainfall had a disastrous effect upon some of the station work, as there are no facilities for irrigation and only meager supplies for use in the pot and other experimental work. As a result the experiments with cane seedlings and the propagation of other young plants were carried on with the greatest difficulty.

The area devoted to work in agronomy was greatly reduced, and the field crop work is now confined to relatively small tracts. The acreage formerly devoted to growing sugar cane which was sold to mills has been greatly reduced, and the plantings now consist of seedling canes that were developed at the station by the former agronomist. Three varieties which showed the most promise were planted in half-acre plats and grown in comparison with Ribbon and Crystallina, the standard varieties of cane in St. Croix. Excellent reports are still received of the variety S. C. 12/4 originated at the station. This cane has been in the possession of planters for two or three years, and during the past planting season more than 200,000 cuttings were shipped from St. Croix. The upright habit of growth of this cane permits its closer planting, but as it does not shade the ground so well or produce so much trash which acts as a mulch, it will probably not succeed as well in light soils where moisture is a limiting factor in cane production. The number of sprouts coming up from each stool during the dry season which has prevailed was found greatest for the variety S. C. 13/13. About 300 new seedlings were grown in pots during the past year, and they were awaiting favorable rains for planting in the nursery. A rather extensive experiment in sweet potato breeding was begun. In February seed balls were observed in plantings of several of the leading varieties of sweet potatoes, and the seed was collected and sown in flats. The seed germinated very unevenly, but there were on hand at the end of the fiscal year 265 seedlings in nursery hills, each of which is potentially a new variety. Much variation in leaf pattern, color, and vine habit is observed in the different seedlings.

A preliminary trial was made of 22 varieties of cowpeas, and when sown early in December the growth was entirely satisfactory. The yields of shelled peas per acre varied from 327 to 762 pounds, with an average for all varieties of 570 pounds per acre. Work with soy beans was less satisfactory, the highest yields being 545 pounds of seed per acre. A test of a hybrid corn, produced by crossing a strain of local corn with the variety Black Mexican, gave a yield of 17.1 bushels per acre. This strain is thought to offer considerable promise as a table corn. Work with cotton has been abandoned by the station, and, in accordance with a general understanding with cotton planters, all cotton plants and seed have been destroyed. This action was taken on account of the presence in St. Croix of the pink bollworm, and it is hoped that by abandoning cotton culture for a few years the pest can be controlled.

There is an urgent demand for more and better fruits and vegetables in St. Croix and St. Thomas. There is a constant shortage of these products, and the principal supplies for St. Thomas come from the neighboring island of Tortola. A preliminary trial in vegetable growing was begun in the fall of 1921, plantings being made from September to December. Insect pests proved very troublesome to some crops, but on the whole the experiment gave very gratifying results. About 2 acres were devoted to this experiment and very satisfactory results were obtained with pole and bush beans, Lima beans, carrots, eggplant, okra, onions, peppers, radishes, and tomatoes. Less satisfactory results were reported for cabbage, kohl-rabi, and beets, although fair crops of all but cabbage were produced.

Cattle raising is second in importance to the production of sugar in the Virgin Islands. Each of the islands has considerable tracts of land not suited to tillage, and much of the area is well adapted to growing guinea grass, an excellent forage for cattle. Preliminary to taking up work in animal husbandry a study was made of the station herd, that consisted of 26 work animals, cows, young stock, and calves. The individual animals are considered typical of the class of stock in the islands. They are of mixed type, having descended from European importations, with some mixture of zebu or Indian cattle. The 10 work animals of the station averaged 1,294 pounds, and the 9 cows 884 pounds, showing that the stock in the Virgin Islands is vastly superior to the so-called native stock in a number of the Southern States. An attempt was made to obtain data regarding milk production of the cows, but the prevailing method of allowing the calves to suck at the same time that milking is being done tended to give very imperfect data. All the cows had been trained in this way and attempts to milk them without the calf resulted in failure. From one cow there was milked 360 pounds of milk in the first month of lactation and 214.5 pounds in the eleventh month, the calf at the same time getting a considerable portion of the milk. These facts indicate that the native cattle offer a good foundation upon which to build up herds for various purposes. The presence of the cattle tick will retard the introduction of improved stock from elsewhere.

The entomologist continued his studies on the scale insects of the Virgin Islands and added several species to the already long list he has published. He is also giving much attention to the insect pests of economic plants, their life histories, and means for control. Data on cotton and truck-crop insects were also included. About 50 species of insects were found on cotton in St. Croix and 75 species on various truck crops. The life histories and means of control of most of the important species have been determined. Considerable work has been done on the insects attacking sugar cane and tobacco. A test was made during the year of the use of trap pans containing black molasses, such as comes from sugar mills, and kerosene and water for the control of truck-crop pests. It was found that while the trap pans caught many insects, they could not be relied upon to control truck-crop pests. Water with a film of kerosene was more efficient in the pans than the molasses. Wind and rain were important factors in trapping insects, and 63 per cent of all females caught had oviposited before being caught in the trap pans.

## OFFICE OF EXTENSION WORK.

C. B. Smith, *Chief.*

The Office of Extension Work in the North and West and the Office of Extension Work in the South were combined October 1, 1921, into a single Office of Extension Work, covering the 48 States.

The two separate offices of extension work had been gradually approaching each other in their methods of organizing and handling extension work in the various sections of the country, and their final amalgamation into one office was in the interest of simplicity of administration and uniformity of work throughout the entire country. Since the union of the two offices considerable internal reorganization has been effected in order that the work might conform more fully to changes in extension organization and work taking place in the various States.

As the extension work has developed there has been a tendency to separation of the interests of the county agricultural agents, home-demonstration agents, boys' and girls' club agents, and extension specialists, and to make the administrative relations of the different agents too distinct and specialized. This has increased the difficulties of administration of the work as a whole and weakened its unity of operation. In the new organization of the Washington office an effort has therefore been made to emphasize the unity of the extension system as a means for helping the farming people to improve agriculture and country life through the work of men and women agents interested in the rural problem as a whole and so united in their administrative relations that each will promote the best interests of the general enterprise whatever may be the particular tasks assigned them individually.

More definite provision has also been made for correlating the extension work of the different bureaus of the department with similar work carried on in the States through the agricultural colleges and for consideration of national and regional problems of agriculture and country life in connection with the State and county programs of extension work.

As now organized, the Office of Extension Work consists of two divisions, (1) the Division of Programs, dealing essentially with the administrative or business side of extension work, and (2) the Division of Methods, dealing more especially with the professional or technical side of extension work. L. H. Goddard, formerly in charge of the farm-management demonstration work of the Office of Extension Work in the North and West has been placed in charge of the Division of Programs, and A. B. Graham, formerly in charge of the work of specialists of that office, has been placed in charge of the Division of Methods. These two divisions replace the county agent, home-demonstration agent, boys' and girls' club, farm management, and specialist sections in the Office of Extension Work in the North and West, and the regional divisions and clubs and home demonstration sections in the Office of Extension Work in the South.

The funds employed in support of extension work carried on by the Office of Extension Work in cooperation with the States during the year for all purposes totaled as follows:

| | |
|---|---|
| Washington administration | $235, 000 |
| State administration | 1, 009, 847 |
| County-agent work | 9, 670, 786 |
| Home-demonstration work | 2, 980, 741 |
| Boys' and girls' club work | 1, 244, 092 |
| Extension specialists | 3, 182, 747 |
| Extension schools, fairs, publications, and miscellaneous | 409, 147 |
| Total for all purposes | 18, 732, 360 |

The staff on the pay roll of the office at the rate of $1 or more per year on June 30, 1922, was as follows:

| | |
|---|---|
| County-agent work (men) | 2,433 |
| Home-demonstration work (women) | 975 |
| Boys' and girls' club work (men and women) | 328 |
| Total | 3,736 |

as compared with a total of 3,707 on June 30, 1921.

In addition to the above, the land-grant colleges, with which the office is cooperating, were employing approximately 750 subject-matter extension specialists.

During the year considerable concern was expressed by various business interests relative to the part county agricultural agents were taking in aiding farmers in their marketing problems, holding that the primary function of such agents under the Federal cooperative agricultural extension act of 1914 was to aid farmers in matters of production rather than marketing. The Secretary of Agriculture held, however, that the carrying on of extension work in marketing by county agents is an entirely proper extension activity, and that it is as much the business of such agents to aid farmers in an educational way in their marketing problems as it is to counsel with them on matters of production. This point of view has been generally accepted by administrative officials in charge of cooperative extension work in all of the States, with the understanding, however, that the agent shall not himself buy or sell for the farmer or any farmers' association, but rather shall teach farmers the principles and methods of marketing, cooperatively or otherwise.

During the year the fact has also been impressed upon the public consciousness that the county agricultural agent is essentially a public official and therefore may engage with propriety only in business of a public nature, being administratively responsible to the land-grant college of the State concerned, regardless of the sources of funds which enter into his employment.

Notwithstanding the depressed condition of agriculture at the beginning of the year, the number of those engaged in county-agent work was increased by more than 50. There still remain, however, around 300 agricultural counties without county agents.

Extension work to meet the needs of the farm home was considerably increased during the year, though the number of those engaged in home-demonstration work was increased by only about 40. Especial effort has been made in many of the States to encourage the county agricultural agents in counties where no home-demonstration agent was employed to give attention to the problems of the rural home as well as general farm problems. The county agents have thus rendered special assistance in placing water, heating, and lighting systems in rural homes, the development of home gardens, and the encouragement of the women to organize in order that they might receive the help of extension specialists from the land-grant colleges in nutrition, clothing, household management, and like matters. In the sections of the country where home-demonstration work is relatively new there is increasing evidence that as farm women become acquainted with its purposes, and the help it affords in solving rural home problems, they are giving it increased support. The future development of this phase of the work on anything like a parity with the agricultural work is dependent primarily on this increasing interest of the rural women, as well as on increased financial support from public sources.

The boys' and girls' club work has maintained its popularity with the people and is being increasingly recognized as one of the most efficient agencies in demonstrating the value of improved practices in agriculture and home economics, though there has been no increase in funds in this project and a decrease of nearly 50 in the number of people giving their whole time to the work. On the other hand, many of the county agricultural agents and home-demonstration agents, who have heretofore not undertaken club work along with their other duties, have been encouraged to develop this phase of their work so that the total results in club work for the year are comparable with those of other years.

Results secured in the work of the county agricultural agents, home-demonstration agents, and boys' and girls' club agents, and in certain phases of specialist work are given below.

### COUNTY AGRICULTURAL AGENT WORK.

The number of county agricultural agents on June 30, 1922, was 2,086, an increase of 12 over the corresponding period in 1921. It is significant that during a year of severe agricultural depression the number of county agricultural agents not only held its own but increased slightly. The loss of local appropriations in a few counties where the work has been conducted for several years was more than offset by the addition of new counties. With the return of better farm prices, it is believed that most of the counties which have discontinued county-agent work during the past year will again provide the necessary local support. In addition to the county agents there were also employed 48 assistant agents and 154 State supervisors and assistant supervisors. One hundred and forty-five local negro agents were employed to work with farmers of their race.

#### ORGANIZATION.

Experience has conclusively proven that the county agents can accomplish more and better work by working through organized groups rather than by doing personal-service work. While considerable work with individuals is still necessary, this is being gradually reduced and more emphasis placed on organized work. Of the 2,086 counties having organized extension work, 1,735 reported some kind of a county organization of farming people assisting in the prosecution of extension work; 20,232 communities were organized to cooperate in the local conduct of the work; and 77,518 county and community leaders actively participated in forwarding the county and community programs of work. Continuous progress is being made in truing up programs of work with census data and other available information in order that they may the more nearly correspond to local needs over a period of years. Marked progress is also being made in bringing about greater definiteness in these programs.

These facts would seem to indicate that the extension workers are becoming more interested in county extension organizations as a means of supplying effective machinery for advancing the local extension program, whatever other purpose they may serve as an organization of rural people.

### SUPERVISION.

The past year witnessed marked progress in the work of the State supervisors and assistant State supervisors of county agents. During the earlier years of the work, and especially during the period of the war, their work consisted chiefly in organizing new counties and keeping a full quota of agents employed and at work. They are now giving more and more attention to assisting the agents with problems connected with the successful organization and conduct of the work in the counties, as indicated by the number of farmers effectively reached. The most successful supervisors are basing their plans or programs on careful studies or analyses of the work in the counties. When the county needs have been definitely determined, the supervisor then proceeds to make his plans for correcting these needs in so far as possible, either through better organization of the work or the employment of methods that have proven successful in other counties and in other States. More attention is being given to putting the work in the counties on a better business basis, from the standpoint of complete and accurate records and reports. Agents and supervisors throughout the country are recognizing the necessity for better records, both from the standpoint of obligation to the public and more efficient prosecution of the work.

### METHODS.

County-agent work has now reached the point in its development where leaders and agents are studying the effectiveness of the various methods of organizing and conducting the work. More thought is being given to the use of demonstrations, not for their own sake but as an effective means of influencing the adoption of better farm practices. An effort is being made to try to answer such questions as the following:

> Is the field demonstration more effective than the meeting, circular letter, newspaper article, or other means in successfully accomplishing a desired result?
>
> How many demonstrations of a particular kind are necessary to effectively cover the entire county or a certain portion of it?
>
> For how many seasons is it necessary to conduct field demonstrations in a particular practice to secure the desired cumulative results?

So much interest has now been aroused that several institutions are taking steps to learn more definitely the comparative effectiveness of the various means, agencies, or methods that the county agent may employ in carrying on his extension work.

### SOIL IMPROVEMENT.

A total of 18,039 demonstrations were conducted in the various phases of soil improvement; 3,861 drainage systems were planned and adopted, involving 614,059 acres; 275,012 farmers were given assistance in the proper use of commercial fertilizers; 426,955 acres of clover and other legumes were plowed under for green manure;

soil was tested for acidity on 28,044 farms; while 41,191 farmers used 548,286 tons of lime or limestone at the agents' suggestion.

### CROPS.

The crop work was largely concerned with the cereal crops (corn, oats, wheat, barley, and rye), cotton, tobacco, orchards, vegetables, and root crops.

### CEREALS.

The work with corn involved 11,034 field demonstrations in seed testing, seed selection, cultural practices, and the like; 43,686 farmers were helped to secure 136,403 bushels of seed corn of improved strains; and farm practice relative to corn growing was modified on 778,838 farms.

In all, 5,056 demonstrations were conducted in wheat growing—2,527,781 bushels of seed were treated for smut, 23,049 farmers were assisted in securing 726,056 bushels of improved wheat seed, and 173,117 farmers were influenced by the county agents to modify their farm practices relative to wheat growing.

An important phase of the work with oats was the treating of 1,241,822 bushels of seed for smut, the conducting of 4,765 field demonstrations, the assisting of 10,481 farmers to secure 341,376 bushels of improved seed, and the influencing of 121,260 farmers to change their farm practices in connection with oat culture.

A total of 1,914 demonstrations were conducted with rye, and 31,181 farmers were influenced to change their methods of growing this crop.

### POTATOES.

The reports show that 277,777 acres of potatoes (Irish and sweet) were planted with seed treated for disease; 12,873 field demonstrations were conducted and the farm practice relative to potato growing changed on 220,259 farms; and 28,799 farmers were helped to secure 548,975 bushels of better seed.

### LEGUMES.

The work with legumes included alfalfa, soy beans, velvet beans, cowpeas, peanuts, crimson clover, sweet clover, red, alsike, and white clover, vetch, lespedeza, and the like, grown either for soil improvement or for forage purposes. This work is summarized in the following table:

*Demonstrations with legumes.*

| Kind of legume. | Number of demonstrations. | Number of farmers influenced to change practice. | Kind of legume. | Number of demonstrations. | Number of farmers influenced to change practice. |
|---|---|---|---|---|---|
| Alfalfa | 3,702 | 30,368 | Clover—red, alsike, white | 492 | 52,520 |
| Soy beans | 4,729 | 49,387 | Sweet clover | 1,324 | 14,932 |
| Velvet beans | 2,573 | 45,153 | Lespedeza | 847 | 12,095 |
| Cowpeas | 4,377 | 50,095 | | | |
| Peanuts | 1,447 | 17,430 | Total | 20,700 | 289,137 |
| Crimson clover | 1,209 | 17,157 | | | |

### COTTON.

Through the extension agents. 25.436 farmers were assisted in securing 1.657.757 pounds of improved cotton seed, 4,245 demonstrations were conducted, and 144.090 farmers influenced to adopt better practices relative to the growing of this crop.

### ORCHARDS.

A total of 37,190 demonstrations in the growing of orchard fruits were conducted by the agents, 8,216 farmers were assisted in starting new orchards. 39.465 farmers were assisted in pruning and 37,317 farmers in spraying fruit trees.

### MISCELLANEOUS CROPS.

A large amount of work was also done with other crops, including 15.754 unclassified crop demonstrations, 10,126 demonstrations in pasture improvement, 19.921 farmers influenced to adopt better practice of tobacco growing, work with Sudan grass, sorghum, and many other crops.

### INSECTS, RODENTS, AND ANIMAL PESTS.

The control of insect and rodent pests is an important phase of extension work in many sections of the country. This is due to the fact that control measures have been well worked out, and the value of this work is quickly reflected in larger harvests. So widespread and severe are the attacks of such pests in the newer sections, too, that they often produce emergencies which must have the quick and concerted action of agent and people. In all, 68.244 farms were assisted in controlling rodents on 13.508.452 acres, and 73.665 farms practiced insect-control measures on 2.409.528 acres under the direction of county agents.

### LIVE STOCK.

The principal phases of extension work with live stock have been the securing of high-grade and purebred stock, especially purebred sires; the organization of cow testing and breeders' associations; feeding and culling and the control of live-stock diseases. In this work, 31.654 purebred sires of all kinds were placed on farms not before having purebred sires or to replace purebred sires of inferior quality; 62.082 purebred females were placed on farms as foundation stock for purebred herds; 451 cow-testing associations were organized or reorganized during the year; 50.355 farmers were assisted in computing balanced rations; 25.176 farmers were interested in using self-feeders for hogs; silos were erected on 4.552 farms; poultry practice was modified on 161.377 farms; 1,065,098 animals were tested for tuberculosis in cooperation with State and Federal agencies; 519.759 animals were treated for blackleg; 909,902 hogs were vaccinated for cholera at the agents' suggestion; and 901 live-stock breeders' associations, with a membership of 21.190, were organized during the year. The following demonstrations were conducted with live stock:

*Live-stock demonstrations.*

| Kind. | Number. | Kind. | Number. |
|---|---|---|---|
| Dairy cattle | 4,712 | Poultry | 31,212 |
| Beef cattle | 2,497 | Horses and mules | 882 |
| Blackleg control | 5,782 | Silos | 161 |
| Sheep | 635 | Unclassified live stock | 6,695 |
| Swine | 6,362 | | |
| Hog cholera | 18,224 | Total | 77,162 |

### AGRICULTURAL ECONOMICS.

The county agents have continued to devote a large amount of time to assisting farmers with problems connected with the marketing of their crops and live stock. During the year the county agents gave such assistance in connection with 7,078 cooperative-marketing associations, which did $349,807,153 worth of business with an estimated saving to farmers of $23,791,869. In addition, 62,927 account books were placed in the hands of farmers and 35,472 farmers were influenced to adopt better cropping, live-stock, or complete farming systems. Buildings other than homes were constructed or remodeled on 19,035 farms according to plans furnished through the agents.

### FARM HOME.

Water systems were planned and installed in 3,419 homes, sewage-disposal systems in 2,894 homes, and lighting systems in 4,861 homes. Houses were constructed or remodeled on 10,239 farms. Home grounds were improved on 16,061 farms, and practices relative to gardening changed on 106,719 farms.

### GENERAL ACTIVITIES.

In the prosecution of their work during the year the agents made 1,456,860 farm visits, handled 3,110,647 office consultations, and held 465,752 meetings with a total attendance of 14,125,514 persons. They prepared 157,565 newspaper articles relating to their work, wrote 2,806,769 individual letters, and prepared 212,296 circular letters with a circulation of 15,972,626.

### OUTLOOK.

Having passed through the periods of early growth and rapid expansion, county-agent work is now emerging from the period of agricultural depression and is well started on a period of consolidation. More thought than ever before is being given to more effective use of the county extension organization in forwarding extension programs, to determining the more efficient methods and eliminating the less efficient methods, and to the general adoption of better business methods of handling the work. The next few years will, no doubt, witness marked progress in the standardization of the work and the development of a technique of the profession of extension work.

### HOME-DEMONSTRATION WORK.

The number of county home-demonstration agents increased substantially during the year, indicating an increasing appreciation of the services of these agents. On June 30, 1922, there were 767 county home-demonstration agents as compared with 713 on the same date in 1921. In addition there were 12 assistant agents and 122 State supervisors and assistant State supervisors of home-demonstration work as well as 104 negro home-demonstration agents employed to work with negro women.

#### ORGANIZATION OF THE WORK.

As in county agricultural-agent work, the value of organized effort is equally apparent in home-demonstration work. In order that the same effort may effectively reach more farm homes, the home-demonstration agents are devoting more and more time to the conducting of practical object lessons that may be observed and copied by a large number of people, and to the training of voluntary local leaders who will assist in forwarding local extension programs. There was considerable progress during the year in making home-demonstration programs more definite and better adapted to the needs of the various counties and communities.

#### GENERAL ACTIVITIES.

In connection with their work, the home-demonstration agents made personal visits to 168,204 homes to give advice, render assistance, or observe the progress of demonstrations. In connection with this work 402,638 office consultations were held by the agents, who also wrote 904,582 individual letters answering requests for information. It is estimated that as a result of the activities of the agents 689,952 new home practices were adopted by nearly as many farm homes.

#### FOOD PRESERVATION.

Food preservation, including canning, drying, brining, and storing of vegetables, fruits, and meats, continued to be a very important phase of home-demonstration work. The number of adult demonstrations and the number of cases of adoption of the practices demonstrated are given in the following table:

*Demonstrations in food preservation.*

| Kind of demonstration. | Number of demonstrations. | Number adopting new practices. |
|---|---|---|
| Vegetables and fruits: | | |
| Canning | 33,765 | 109,534 |
| Drying | 5,977 | 20,392 |
| Brining | 5,399 | 14,745 |
| Storing | 4,587 | 14,499 |
| Meat | 7,277 | 25,065 |
| Total | 57,005 | 184,235 |

## FOOD PRODUCTION.

The producing of additional poultry and dairy products and the growing of additional vegetables and fruits, either for home consumption or as a means of increasing the farm income, continued to receive a large amount of attention. As indicated in the following table, 57,053 demonstrations in food production were conducted and 170,733 adopted new production practices as a result:

*Demonstrations in food production.*

| Kind of demonstration. | Number of demonstrations. | Number adopting new practices. |
|---|---|---|
| Poultry | 24,000 | 77,196 |
| Gardening | 23,052 | 54,316 |
| Dairying | 9,736 | 38,758 |
| Squabs, rabbits, fish, bees | 265 | 463 |
| Total | 57,053 | 170,733 |

## CLOTHING AND MILLINERY.

The work in these subjects included the selection of textiles and clothing, garment making, renovating, millinery, and the making of gummed-paper dress forms, and involved 67,889 demonstrations by the agents, as a result of which 105,861 families adopted new practices relative to clothing. The saving resulting from the making and renovating of garments, use of dress forms, and the like is estimated at $902,428.

## FOOD AND NUTRITION.

There were 28,961 demonstrations in connection with the various phases of food and nutrition, as a result of which 62,094 families made changes in practices with regard to the selection and preparation of food, the use of milk in the diet, hot school lunches, and child feeding.

## HOME MANAGEMENT.

The keeping of household accounts, use of equipment, and general organization of routine duties to save time and labor called for 6,200 demonstrations and influenced 9,742 families to adopt more successful practices.

## HOUSE AND LAWN.

The building and remodeling of houses; redecorating and refinishing; the installation of lighting, water, and sewage-disposal systems; the improvement of the home grounds; and the like all received attention during the year. In all there were 10,944 demonstrations, resulting in the adoption of 21,424 new practices.

## HEALTH.

The work along health lines has been carried on in cooperation with State and local health officers and special organizations engaged in health work. The prevention of disease through the adoption of better nutrition and sanitary practices, home nursing, and child care received particular attention. In all, 12,700 demonstrations were conducted and 21,737 families were influenced to adopt better health practices.

### COMMUNITY ACTIVITIES.

In addition to the work with individuals and farm homes, considerable emphasis was placed during the year on the development of activities of a community-wide interest. These enterprises include community canning, drying, salvage shops, rest rooms, cooperative buying and selling associations, cooperative laundries, recreation centers, fairs, curb markets, egg circles, and the like. All of these tend to draw rural people closer together for business and social purposes, and develop concerted action in the handling of some of the larger rural problems.

### OUTLOOK.

It is expected that home-demonstration work will continue to grow on a conservative basis with the addition of home-demonstration agents in a small number of counties each year. This increase will no doubt become more rapid as the prices received for agricultural products rise and farmers and farmers' wives become more cheerful in regard to the outlook for a more prosperous agriculture and a more satisfactory rural life.

### BOYS' AND GIRLS' CLUB WORK.

On June 30, 1922, 122 State club leaders and assistant State club leaders, 201 county club agents, and a majority of the 2,086 county agricultural agents and of the 767 county home demonstration agents were actively engaged in carrying on extension work with juniors. Supplementing the work of these cooperative employees were more than 10,000 local adult leaders, who gave their services without pay. While the total enrollment of 490,642 shows a slight decrease from that of the previous year, yet 285,477 (or 58 per cent) of the boys and girls completed their demonstration work in 1921, which is more than in any preceding year. The total value of all products produced by club members was computed at $7,069,877; 20,626 club groups were organized; 140,627 club members exhibited their products at 10,220 State, county, and community fairs; 1,625 club encampments were conducted, with a total attendance of 62,969 boys and girls. For the past three or four years the effort has been to make the club activities conform entirely to the farm and farm-home needs of the various communities and counties. The past year's work has brought this objective within reach as a complete attainment. Extension workers have given special attention to those controllable factors which help to determine the quality of their demonstration. Older boys and girls, up to an age of even 24 and 25, are being encouraged to take part, and their additional experience has raised the standard of work. Larger acreage and larger numbers of animals or home units used in the demonstrations have been adopted in order to make the results more convincing. Greater volume, or number of demonstrators per community, has been encouraged in order to more quickly establish new practices. As a result boys' and girls' club work more successfully and more widely demonstrates better practices than heretofore.

### CROPS.

In connection with crop work, 28,850 boys and girls were enrolled in the work with corn, 3,030 with grain sorghum, 3,328 with peanuts, 11,781 with Irish potatoes, 2,114 with sweet potatoes, 287 with oats, 215 with peas, 425 with beans, 2,587 with seed cotton, 761 with wheat, 73,462 with garden crops, 2,550 with orchard crops, 3,848 with grapes and other small fruits, and 2,870 with miscellaneous crops. The total value of crops grown and reported by club members was $1,676,373.

### LIVE STOCK.

More boys and girls (67,091) were reached through the poultry project than in any other live-stock enterprise. Swine was a close second, however, with an enrollment of 53,174, while 4,912 boys and girls were enrolled in beef-cattle work, 8,626 in work with dairy cattle, 2,392 with sheep, and 216 worked with other live-stock enterprises. The total value of live stock and live-stock products produced by club members was $3,605,176.

### HOME ECONOMICS.

Work with clothing and textiles, with an enrollment of 86,330, was the most popular of the home-economics projects; canning was next, with an enrollment of 52,232; and baking of bread and other products third, with 31,605 enrolled. There were 2,639 enrolled in drying and curing, 1,749 in brining, and 489 in storing of meats and vegetables. Work with milk and milk products interested 2,776, meal preparation 8,948, hot school-lunch work 4,833, while house and lawn improvement enrolled 12,785. Handicraft work was carried on by 1,827 boys and girls. There were also 12,010 boys and girls enrolled in various activities not mentioned above. The total value of home economics and miscellaneous products was $1,788,326.

### OUTLOOK.

That most improved phases of farm and home practices can be demonstrated by boys and girls is quite generally recognized. In fact, extension workers are realizing that many farm and home practices can be best demonstrated through boys and girls, and the latter will no doubt play an increasingly important part in the prosecution of the extension program in the future.

### WORK OF EXTENSION SPECIALISTS.

Extension specialists of the State agricultural colleges have made great advances in developing the work according to plans and programs that fit into the year's work of the county extension agents, and in working out better methods of teaching and better plans for influencing and changing practices through the demonstration. There has been a gradual tendency to follow the needs of a county or community as determined cooperatively by the specialist, the county agent, and the county extension organization. Better follow-up systems are being devised and more accurate records of subject-matter work are being kept, both at the colleges and in the county agents' offices.

There has been more stability as to tenure of positions among the specialists than during previous years, and this has insured more careful follow-up work and has helped in making observations as to the influence of demonstrations.

Specialists in other bureaus of the department, although employed on investigational work, have had opportunity to observe and comment on the results of extension work in the States, especially in those lines of work that are carried out cooperatively by the States and the United States Department of Agriculture.

Weekly conferences of the department's extension specialists have been continued through their fifth year, and more attention than previously has been given in them to discussion of methods of carrying results of the investigational work of the department to the States. The importance of a closer relationship of the specialists to the organization work has been realized through the weekly meetings. To bring about a clear understanding of organization methods, members of the organization staff were brought into the conferences to explain their work in the field and their methods of building a machine through which department subject matter might reach people on the remotest farms.

The following is a brief summary of the outstanding features of the work of extension specialists during the year:

### AGRONOMY.

The principal work in 1921 with soils consisted in holding demonstrations to show the value of lime in securing better legume crops, developing cheaper sources of lime, and of securing cheaper freight rates to the farmers on agricultural limes. Demonstrations were held to show the value of high-grade fertilizers in saving freight and handling charges. Other general lines followed were soil-erosion work and soil-survey study, using the Federal soil surveys as a basis for detailed study of soils in various counties.

Crop work was principally along the lines of seed improvement, including selection and distribution of high yielding strains of purebred seeds and developing the work of seed inspection and certification. Almost every State is doing something in the way of developing better seeds of high yielding varieties. A definite campaign was put on in a number of States to increase the acreage in legumes used in regular crop rotations. The principal legumes used were red clover, alfalfa, sweet clover, soy beans, and cowpeas. Pasture demonstrations have been put on in a number of States to improve the permanent pastures, especially in the rough, hilly sections where there are large tracts of land not suitable for cultivation.

### DAIRY INTRODUCTION.

The principal activities of dairy-introduction specialists were developing cow-testing associations and bull associations, utilization of dairy products, Swiss-cheese manufacture, American-cheese manufacture, creamery operation, and butter making. Minnesota and Wisconsin increased the number of cow-testing associations approximately 50 per cent during the year. There was a 25 per cent increase in bull associations in the United States during the year. Milk-utilization work was carried on in nine States, and reports indicate an increase of from 5.5 to 20 per cent in the consumption of milk as a result of this work. American-cheese manufacture was carried on in North Carolina, Tennessee, and Georgia, there being more than 40 factories now operating in these three States. Creamery-introduction work was carried on in Tennessee, Mississippi, Louisiana, and North Carolina, and effort of the specialists was directed toward improving the quality of the milk delivered to the creameries. During the year dairy specialists made 3,127 farm and factory visits and attended 766 meetings, with a total of 44,006 people in attendance.

### ENTOMOLOGY (BOLL-WEEVIL CONTROL).

Two specialists spent their entire time on the control of the cotton-boll weevil, in seven cotton-producing States. Although they gave attention to all methods, the majority of their time was given to poisoning by dusting with calcium arsenate, a method which has proven very effective. It is estimated that fully 20,000 people attended the meetings and demonstrations, and approximately 12,000 people witnessed the two motion-picture films, "Good-bye boll weevil" and "How to poison the boll weevil."

### HORTICULTURAL WORK.

The most striking feature of extension work in horticulture was in the formation of several hundred cooperative "spray rings" of from 3 to 15 members each. In most cases, the power sprayer used is paid for jointly by the members, and is operated either by one member or by a man hired for that purpose. In a few cases, one man buys the outfit and charges the other members a certain fee per tree for the season. Iowa has more spray rings than all the other States combined.

Cooperative fruit grading, packing, and marketing associations are proving very popular in New York and are spreading into a number of other States.

In the Pacific Northwest, the practice of growing cover crops of alfalfa, vetch, and red clover has been the solution of the apple industry.

General supervision of the garden and other agricultural work of the District of Columbia was continued, 400 garden plots being planted in East Potomac Park in addition to the large area on the Anacostia Flats. This work has proven very popular with the people of Washington.

### PLANT PATHOLOGY.

Extension workers in pathology directed their attention to introducing control measures for the more important diseases of farm crops. Progress was made in the establishment of practices which tend to check such serious diseases as corn-root rot, stem rust of wheat, smut on wheat and barley, potato late blight, mosaic and Rhizoctonia, sweet potato stem rot, watermelon stem-end rot, anthracnose, downy mildew, and black rot of the grape.

The State specialists in pathology are devoting more and more of their time to carrying on definite projects with field demonstrations. Many of these projects are handled in cooperation with the research workers of the Bureau of Plant Industry. There is also a tendency to decrease the number of projects being carried by the various specialists in this line of work and to emphasize the really important disease-control measures.

### FARM MANAGEMENT.

Among the principal lines of farm-management work were the conducting of 800 farm-management schools, attended by more than 20,000 people; the keeping of farm account books on 18,448 farms; and the assisting of 8,454 farmers to summarize their year's work. Reports indicate that as a result of this work 2,972 farmers made changes in their farming operations; 6,590 farmers were assisted in planning a rearrangement of their farm buildings and equipment to economize time and labor; and 10,964 farmers adopted new cropping and live-stock systems upon the recommendation of the farm-management specialists. Twenty-five landlord-tenant meetings were attended by approximately 2,400 people. As a result, 2,003 farmers were assisted in drawing or modifying farm-lease contracts. Twelve farm-management tours were conducted, the object being to teach the fundamental principles of good farm organization through visits to successful farms. Sixty-three farm-management exhibits were prepared for State and county fairs.

### FOOD AND NUTRITION.

The development of extension work in this subject was along lines of proper food selection for the family, with special stress upon child feeding and many demonstrations in cooperation with the local organizations working with groups of underweight children. Demonstrations in the homes have been very popular and have shown the relationship between proper food habits and body conditions for both children and adults. In this connection, proper food gardens were stressed in a number of States, especially in the farm communities.

### HEALTH.

A number of States have employed home-health specialists, whose time was given to various phases of personal hygiene and sanitation, in cooperation with the State and county health boards, and dental clinics were held. Fly control, clean-up campaigns, and safe water supplies were also given attention. In boys' and girls' club encampments instruction was given in health standards and in food and health habits.

### CLOTHING AND HAT MAKING.

The principal features of this work were the making of dress forms, alteration of patterns, and making of fitted-to-measure foundation patterns, clothing construction, use of machine attachments, clothing hygiene (including the selection of shoes and corsets), and hat making, including selection of material for quality and design. This work has proven very popular and in many sections has been organized with the idea of using local leaders. Representatives of communities are selected and then trained for the entire county by the specialists in simple, practicable methods of garment and hat making. These leaders then go back to their community to give the work to the organized group of women and girls. The success of this work has been largely due to the training of local leaders and to keeping the work along simple, practical lines.

### HOUSEHOLD MANAGEMENT AND FURNISHING.

This work was largely along lines of installing inexpensive, labor-saving equipment, usually starting with the kitchen and laundry, and providing running water and sewage disposal. From this, other phases of home improvement have been developed, as money and time were available, among them being home furnishing and decoration.

### NEGRO AGENTS' WORK.

There is probably no line of extension work making more substantial progress than that carried on for the negro farmers in the Southern States, the only section in which this work has yet been systematically organized. In these States there is now a well trained, organized force of negro agents who work with the negro population in those sections most thickly settled by members of their race. It is a notable fact that the best organized and most effective work among the negroes will be found in those States which have developed strong negro agricultural schools. The influences going out from these institutions and the courses of training given the students attending them have proved of wonderful help in the promotion of satisfactory negro extension work. A considerable number of the young men and women turned out from these institutions seem to be specially fitted for the work and have been inspired with a desire for service. They make exceptionally good extension leaders among their people. This is especially encouraging, because the greatest need of the negro rural population is wise and safe leadership.

It is a source of great satisfaction that a very large percentage of the negro agents selected up to date have been able to render a real service to their people in dealing with the various difficult problems that have confronted all the people in the cotton-growing States in recent years.

There was a substantial increase in the number of negro agents employed during the year. A more important feature, however, than the increase in the number of workers is the marked improvement of those already at work and their increased ability to guide and assist their people in the application of better methods in solving many of their problems.

There are employed at the present time 2 negro field agents, 160 men agents (county and supervisory), 107 women agents (county and supervisory), and 9 club agents, making a total of 272 field workers. The work is supported from Federal, State, and county funds, just as are all other lines of extension work. Wherever possible the work in the State is carried on in cooperation with the negro agricultural college, and usually the negro supervisors are located in these institutions. One result of this cooperation with the negro schools has been to cause those in charge of them to devote more thought to the teaching of agriculture and allied subjects. A few of these schools are making some special effort to train young men and women to become extension workers.

The two field agents employed by the Washington office are cooperating with the State directors and other white supervisory forces in organizing the negro work in the States. They assist the negro supervising agents to plan their work, prepare reports, and give instruction to new agents, and to keep their programs balanced so as to render the most efficient service to the greatest number of people. They give special attention to maintaining the right spirit and harmonious relationship between the races throughout their districts.

There was no change during the year in the general program for carrying on the work. The fundamental idea of improving farm conditions and making every farm as nearly self-supporting as possible has been kept in the foreground. Noticeable progress can be observed in the types of homes and in the general appearance of the people where the work has become established. In these sections negro agents are called upon for more advanced lines of work. New homes are being built; old ones improved; orchards, gardens, and good live stock are becoming the rule rather than the exception. There is a growing desire for better schools and churches, and for improved sanitary, health, and social conditions—things that always follow real development in any community.

The white agents are still giving a great deal of assistance to the negro farmers in every State where there is a large negro population, and doubtless will continue to do so wherever opportunity is afforded. There are, however, many problems peculiar to the negro and his home life with which they can get more helpful assistance and advice from agents belonging to their own race, provided they have had the right training and possess the proper viewpoint.

In those communities where the work has been carried on longest much is being done through the negro organizations, such as community farmers' clubs, fair associations, churches, and schools. A few sections have advanced to the organization of county advisory boards made up from representatives of the local clubs. There were reported in 1921, 885 negro farm clubs, with a total membership of 40,173, of which 269, with a membership of 12,215, were organized during the year. Considerable assistance was given the negro farmers in organizing cooperative selling and purchasing associations. It was reported that the farmers purchased through these associations during the year $372,000 worth of supplies at a saving to them of more than $80,000. There were fewer demonstrators and club members listed than last year, but, considering the conditions under which they were obtained, the total results are more striking. The men agents report 14,116 demonstrations in field crops, covering about 68,948 acres. The chief crops were corn, cotton, oats, cowpeas, peanuts, and potatoes. The increased yields reported on the demonstration farms range from 40 to 75 per cent higher than those of adjoining farms where ordinary methods were used.

Some of the miscellaneous work accomplished through the negro men agents, as shown in their reports, was as follows: Four thousand one hundred and thirty-one home orchards inspected, 2,456 home orchards pruned, 1,253 home orchards sprayed, 643 new home orchards with a total of 3,193 trees were set out, 2,553 farmers were induced to terrace land, 3,459 farmers grew grazing crops for hogs for the first time, 18,509 home gardens were planted, 5,315 farmers planted cover crops for improving their soil. The agents made 92,094 visits, traveled 453,506 miles, and had 23,694 calls at their homes or offices from negro farmers asking for instruction and advice on various subjects.

The men and women agents combined efforts in establishing 2,492 poultry demonstrations and placing 2,320 purebred flocks; influenced the buying of 1,379 family cows; assisted in improving and remodeling 5,059 dwellings; screened 11,548 and improved the sanitary conditions in 7,945 homes. More than 10,000 home grounds were improved and beautified by the planting of trees, shrubs, flowers, and vines.

## OFFICE OF HOME ECONOMICS.

C. F. LANGWORTHY, *Chief.*

In the science and practice of agriculture the problems of production can never be wholly separated from those of distribution and consumption, and many of the latter are best studied in connection with home life. The greater part of all the materials raised on farms find their way into homes where they are used either as food or as the materials for clothing or shelter. Through homes, therefore, must come much of the needed improvement in the methods by which farm products are prepared for human use. In the case of the farm home, too, there is a direct and very important connection between the health and comfort of the members of the family and the prosperity and productiveness of the farm considered as a business enterprise. Homes offer also very favorable opportunities for studying the material needs of the people, which in the long run are the only safe guide to the amounts and relative proportions of the various farm products that should be raised. For these reasons the Office of Home Economics is concerned with collecting and distributing information about the best ways of preparing and using farm products and is at the same time seeking to contribute to that important and slowly increasing body of knowledge which concerns the relation of food, clothing, and shelter to body needs. To this end it is studying by means of the respiration calorimeter the amount of energy expended and the amount of body fuel required under various circumstances, is collecting facts with reference to the normal food consumption of healthy people and the actual standards of living in farm homes, and is in other ways investigating the final use of agricultural products for food, clothing, and other purposes in the home.

The work carried on during the past year in the office laboratories is shown in the following summary:

In the experimental kitchen household methods of preparing pectin extracts from apples and the peel of oranges and lemons have been worked out and these extracts have been successfully used in the making of lemon, orange, strawberry, rhubarb, cherry, pineapple, mint, and spiced vinegar jellies and in jellied preserves of strawberry, peach, nectarine, pineapple, cherry, and raspberry. Quantitative tests on these pectin extracts show that jelly-making power does not run parallel with pectin yield as determined by present methods.

The determinations of the internal temperatures of cooked food by the use of electric thermo-couples were continued. The relations between the length of the cooking period and the temperature attained in the food when baked, boiled, and fried in deep fat were studied in the case of several foods of high protein content and of a few foods rich in starch or other carbohydrate. The results show that in the case of potatoes of nearly uniform size and weight the rate of heat penetration is faster in boiling than in baking. The maximum temperature attained at the center of boiled potatoes is lower for very large potatoes than for medium-sized or small ones, but so far no evidence has been obtained to show that this is the case with baked potatoes. The final temperature attained in peas, cabbage, carrots, and beets when boiled is 100° C., and the time required for reaching this point depends chiefly on the size. Peas, separate cabbage leaves, and sliced carrots attain the temperature of the bath in a short time and remain at that temperature during most of the cooking period. Heat penetrates much more slowly in the case of whole potatoes and beets, and the cooking period is much longer. The results with plain milk-and-egg custard, both boiled and baked, show that the coagulation temperature of a custard varies with the temperature and kind of heating medium, the proportions of protein, water, and acid in the mixture, and the amount and kind of sugar used. Pumpkin custard used for making pumpkin pie also showed considerable variation in coagulation temperature. The maximum temperature at the center, when coagulation was considered to be complete, ranged from 87° to 102° C., depending on the thickness of the filling and the temperature of the oven during baking. The length of time during which the center of the pie registered a temperature above 80° C. varied from 8 to 38 minutes. Thus it appears that 8 minutes was the shortest time during which the coolest part of these pumpkin custard pies remained above 80° C., even ignoring the fact that the temperature at the center of the pie sometimes goes down very slowly after the pie is removed from the oven.

These experiments with pumpkin custards are of interest in view of a recent suggestion that botulism may be caused by infected canned pumpkin used in pie. This, of course, raises the question whether pumpkin custard in pie is maintained at a sufficiently high temperature for a long enough period to insure the destruction of the toxin of certain strains of botulinus.

The studies on pastry making are now practically complete. It has been shown that physical structure and condition of the fat are much more important than chemical composition in making good pastry and that almost any bland food fat or oil may be successfully employed if properly handled and used in the right proportion. Considering only appearance, texture, and flavor, this may be said of some of the hydrocarbons which were studied for comparison. Also, bread flour gives as good results as pastry flour, provided proper proportions of fat and water are added. Salt was found to have a slight toughening effect on pastry dough. The addition of tartrate and phosphate baking powders did not affect the toughness of the dough nor cause an increase in volume.

Several instruments have been tested to find a suitable means of studying variations in consistency of culinary fats. Measurements then made indicate to what extent the consistency is changed after carefully specified manipulation and after storage under known conditions. These studies show clearly the reasons for lack of uniformity in different samples of manufacturers' brands of lards and lard substitutes.

A number of kinds of vegetables have been successfully canned in a bath of strong salt brine, with considerable reduction of the processing period. A study of the effects of processing various fruits at temperatures lower than 212° F. indicates that cherries, plums, and grapes canned by this method are of better quality than when processed at higher temperature. The peaches and plums tested were better when cooked in an open kettle at the boiling point and packed hot.

Tests made with a commercial canning compound (essentially boric acid) showed that when used according to directions on the label it immediately imparted an undesirable flavor to canned sweet corn; also that it failed to prevent spoilage.

Cooperative work is being carried on with the Bureau of Standards to determine the effects of aging on various kinds of rubber rings for glass jars.

The study of the morphological and cultural characteristics of some of the anaerobic bacteria isolated from spoiled cans of vegetables were continued, and data were obtained on the changes that these organisms bring about in fresh materials as well as on the effect of hydrogen-ion concentration upon their development in the cans.

Beef was corned according to three formulas, two for brine cures and one for a dry cure. The dry cure gave a little stronger-flavored meat, especially at first; but after a time less difference in flavor was noted. The meat in both types of cures kept well for four or five months.

Hams cooked in a pressure cooker required 15 minutes per pound instead of 25 minutes as when simmered in water, and the quality was equally good. Experiments also showed that tender hams may be soaked and baked rather than boiled and baked, but more gas is consumed by the first method because of the longer baking period.

At the request of the Bureau of Animal Industry, cooking tests were made with hams, shoulders, and bacon taken from experimentally fed hogs and cured by different methods; and canning tests with pork products were carried on.

At the request of the Bureau of Plant Industry, trials were made using soda to reduce the astringency of persimmons; imported varieties of greens were tested to determine cooking qualities; and a number of almond pastes and other almond preparations were made into macaroons according to different recipes.

The use of lime, alum, and salt water cures for hardening watermelon rind when preserving was studied. Each product has a characteristic texture and volume, but it was found that preliminary hardening by any of these chemicals is unnecessary.

The cooking of vegetables received some attention. The statement that peas toughen if cooked in salted water was found to be without foundation, when Washington city water and a certain well-known brand of salt were used. Protein losses were practically identical in salted and unsalted water. Similar experiments are being made on other vegetables, and the effect of cooking in various quantities of water and of steaming are being studied. Green-leaf vegetables are receiving particular attention, because of the important rôle assigned to them by modern nutrition specialists.

There has been a great demand for directions for using oven thermometers as a guide in baking, and a large number of tests have been made in different ovens to verify and extend the chart of oven temperatures prepared by the office.

Exhibits showing the baking qualities of flour from wheat grown in Alaska, of corn flour and corn meal, and of adlay flour (made from a variety of Job's tears) were prepared, and the baking qualities of five varieties of Alaskan potatoes were tested.

Tests were made of 24 flavored vinegars prepared by household methods. The flavoring of vinegars involves little time, trouble, or expense, and seems a desirable way of adding variety to the diet.

The digestion experiments of the office have heretofore been conducted with men as subjects, and question has been raised as to whether the results are equally applicable to women and children. Earlier tests of the starches of corn, wheat, rice, and potato, conducted with men as subjects, were therefore repeated with women. As in the previous studies, the starch was served in a frozen pudding with oranges and tea or coffee, if desired, three times a day for three successive days. Though the unusual diet had some psychological effect, the women suffered no serious physiological disturbance, and the analyses so far made indicate that they digested the starches just as completely as did the men. In both cases, the coefficient of digestibility was lowest for potato starch, though there was a rather wide variation among the group.

The respiration calorimeter studies on energy expenditure in household tasks, such as sewing by hand and by foot-operated and motor-driven machines and dishwashing, were continued, and the installation of the special calorimeter for the study of fruits and vegetables under widely differing conditions of temperature, humidity, and gaseous surroundings was completed. A series of experiments conducted in this calorimeter to determine its heat capacity, thermal leakage, and accuracy for energy measurement show that it is sensitive and accurate to a remarkable degree. A paper showing the practical bearing of these studies on fruits and vegetables on cold storage problems was presented at the annual meeting of the American Association of Ice and Refrigeration.

Continuing the cooperation with the Bureau of Animal Industry, attention was given to planning the equipment needed in the poultry research laboratory for studying problems connected with incubation of eggs, which have so far baffled experts in poultry husbandry. Good progress has been made on the construction work in the two rooms that are to comprise the calorimeter laboratory. The fact that the room where the calorimeter is to be placed has been so built that temperature and humidity may be controlled will make possible work of a high degree of accuracy.

In cooperation with the Bureau of Agricultural Economics and with the New York State College of Agriculture, the office surveyed 400 farm homes in Livingston County, N. Y., with a view to obtaining facts on the standard of living maintained in the American farm home. Previous surveys by Federal and other agencies have gathered data on farm incomes, on what the farm contributes directly to the farmer's living, and on various other social-economic conditions relative to farm life. Up to this time, however, none of these studies considered what kind of a living can be maintained on farm incomes and whether it is proportional to capital invested. This survey covered the house and its surroundings, including such important details as furnishings, conveniences, and sanitation; income from various sources and expenditures for such items as food, clothing, education, social welfare, recreation, and doctor's fees and medicine; time consumed in various household tasks, lengths of the work day, and amount and use of leisure; the social life of the family; improvements desired for home and community; and what women consider the greatest advantages and disadvantages of farm life.

As occasion has offered, tests have been made of methods of care and repair of household equipment. The articles repaired were such as came to hand and have included floor coverings, china and earthen ware, glass, and a few miscellaneous articles. The results show that many repairs can be made at home with good results and without any undue labor, which are relatively costly if sent to a professional repairer. A farmers' bulletin on floors and floor coverings and a paper on floor oils were published, and other information on the care and repair of household equipment and furnishings was disseminated through the Press Service of the department.

Two department bulletins, or professional papers, embodying results of investigations by the office, were issued during the year. One of these bulletins, entitled "Food Values: How Foods Meet Body Needs," shows in a new graphic form the special value of various foods in the diet. The other, entitled "Heat Production of Honeybees in Winter," reporting respiration calorimeter experiments conducted in cooperation with the Bureau of Entomology, is a contribution to the information needed by apiculturists to prevent undue losses in bee colonies during winter.

Three farmers' bulletins based on the results of investigations by the office, in addition to the one on floors and floor coverings, were issued as follows: "A Week's Food for an Average Family," discussing good proportions of the various types of foods, using for illustration a week's food supply for the average, or census, family, the unit commonly adopted in studies of cost of living; "Home Canning of Fruits and Vegetables," recording the results of experiments in canning by all the common household methods and pointing out the scientific reasons underlying the preservation of foods by canning; and "Milk and Its Uses in the Home," prepared in cooperation with the Dairy Division of the Bureau of Animal Industry, summarizing the findings of chemists and nutrition specialists concerning the food value of milk and how it can best be handled and used by the consumer.

A circular discussing the essentials of a well-planned kitchen was also published.

Several of the older publications of the office were revised and a number of articles dealing with the work of the office were prepared for publication in scientific journals and through the Press Service of the department.

# REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS.

United States Department of Agriculture,
Bureau of Public Roads,
*Washington, D. C., October, 15, 1922.*

Sir: I have the honor to submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1922.

Thos. H. MacDonald,
*Chief of Bureau.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

## INTRODUCTION.

Without overstatement it may be said that greater progress has been made in providing the means of highway transportation during the fiscal year 1922 than in any similar period in the history of the country. Industrial and financial conditions were better, as a whole, than they have been at any time since before the war, and as a consequence remarkable progress has been made in highway construction under the States and counties as well as under the joint control of the Government and States.

Ten thousand miles have been added to the Federal-aid roads alone, and doubtless more than an equal mileage has been constructed without Federal assistance. And there is now apparent a real public appreciation of the importance of maintaining the roads that are built, an appreciation developed in large measure by the forceful words of the President in his message to Congress.

More significant, however, than the progress in the physical work of road construction, or any other accomplishments of the year, are two developments the results of which are not immediately apparent, and which can not be measured in miles or dollars and cents, but which promise results for the future unequaled by any developments of the quarter century of highway activity.

First of these is the passage of the Federal highway act with its plan for a connected system of roads for the whole Nation; the second is the extraordinary activity in economic and physical research in connection with the financing, location, management, and design of the highways. For more than two decades there has been in progress a slow but certain development of highway construction from a casual activity in the hands of unskilled local officials without plan or program, other than to maintain an established minimum of facility in highway transportation, toward a reasoned industry in the hands of State and national officials, supplemented by intelligent local aid, the aim of which is to provide complete and economical highway transport service throughout the Nation.

In this development the adoption of the Federal-aid highway system provided for by the Federal highway act and the significant researches of the past year constitute the greatest forward steps that have ever been made.

## THE FEDERAL HIGHWAY ACT.

The Federal highway act, approved November 9, 1921, provided for the establishment of a system of public highways the mileage of which shall not exceed 7 per cent of the total highway mileage in any State. The act requires the division of the highways of this system into primary or interstate and secondary or intercounty highways, and limits the expenditure of all future Federal-aid apportionments to this system. The act prescribes that the primary highways shall not exceed three-sevenths of the total mileage which may receive Federal aid and that the secondary highways shall connect or correlate with the primary. It also indicates that the systems in adjoining States shall be correlated.

The selection of 7 per cent of the roads of the Nation for future systematic improvement is unquestionably the largest and most important task ever assigned to the bureau. Its successful accomplishment predicated an unusual knowledge of agricultural, industrial, and traffic development throughout the country and demanded as an indispensable condition cooperation of the closest and most sympathetic kind with all of the States. The terms of the act are brief and general and the conditions actually existing in the United States vary within wide limits, so that it has required very careful study and adjustment to arrange for the designation and approval of the system of roads required by the law. Immediately on the passage of the act this feature of the law was taken under careful consideration and in December, 1921, the first instructions were issued providing for the submission by each of the States of tentative Federal-aid systems within the State. In this way an initial expression of opinion and the result of the studies of the several State highway departments were secured.

Arrangements were then made for conferences between highway officials representing adjacent States in order to secure correlation of the roads suggested for the State systems. These conferences are being followed by other conferences in each Federal-aid district, at which necessary adjustments will be made to bring the designated routes into entire and detailed harmony with the requirements of the law.

At the end of the fiscal year tentative maps showing the systems proposed by the several States had been received from all States except Alabama, Indiana, Minnesota, Mississippi, Missouri, Pennsylvania, South Dakota, Virginia, and Wisconsin, and the first general conference of the States in a field district had been held at Troy, N. Y., at which the tentative systems were correlated for all of New England, New York, and New Jersey.

As an example of the difficulties which have to be overcome prior to the approval of such a system of roads as the law requires is that found in States where road construction is well advanced. In such States a large percentage of the principal roads has been improved, and there has been a natural disposition to designate other roads of less importance as the Federal-aid highway system for the State. The final outcome, however, in all of such cases has been the designation of the most important routes for inclusion in the Federal-aid system. It is realized by the States that the provision of the law, which permits the extension of the system under certain conditions, will successfully meet the practical requirements of construction as they arise. Another condition exists in some of the western States where the population is widely scattered, road distances are comparatively great, and financial resources for road building narrowly restricted. The designation of a system of roads in such States adequate at once to serve local requirements and at the same time correlate satisfactorily with the roads of adjoining States demands very careful adjustments in order to keep the mileage, the resources, and the service value of the roads properly balanced and economically justified.

It has been found that the limitation of the interstate highway mileage to three-sevenths of the whole system in some States of large area and limited total mileage precludes a sufficient length of interstate highways to make connections with the systems of all adjoining States and in such cases it has been found necessary to make use of a portion of the secondary mileage to complete the interstate systems.

At the end of the fiscal year none of the tentative systems submitted by the States had yet been approved by the Secretary, but agreement had been reached with considerable definiteness regarding a large part of the system for the State of Oregon. It is expected that further conferences by districts will be held during the summer and fall and that the approval of the designated systems will commence shortly after the end of the fiscal year.

In order that Federal-aid road construction might not be interrupted during the period required for the designation and approval of the Federal-aid systems required by the law, provision was made for giving approval to particular projects that might be submitted by the State where a reasonable showing could be made that such projects would in fact be included in the probable system. This procedure was authorized by the law, and adequate administrative methods were devised for carrying out construction under these conditions, so that there has been no interrruption or delay in the Federal-aid program of the several States on account of the creation of the Federal-aid system for the country as a whole.

The law requires that within two years from November 9, 1921, maps shall be issued showing the progress in designating the Federal-aid system and thereafter from time to time showing the progress of selection, construction, and reconstruction. Very careful studies are now being made in an effort to arrange satisfactory production of these maps, and in every way possible use will be made of other map-producing agencies of the Government with minimum requirements in the way of original drafting.

## PROGRESS IN ROAD CONSTRUCTION.

From the viewpoint of Federal-aid progress this year, the sixth since the inauguration of the Federal-aid work, divides itself into two periods, the one before and the other after the passage of the

Federal highway act. The first period was a season of great construction activity during which the greater part of the work of completing the 10,000 miles added to the completion column during the year was done. The same period, however, was one of almost complete stagnation with respect to the initiation of projects. When the year opened there was an unobligated balance of $18,793,544 of the Federal-aid appropriations and the projects initiated since the beginning of the work aggregated 35,402 miles. By the end of October the unobligated balance had been reduced to $11,714,328, the lowest it had been since 1918. Only two States, at that time, had a balance of more than a million dollars to draw upon for new projects, and a number were so reduced that their balance was not sufficient to pay for another mile of road. At this time, just before the passage of the Federal highway act, the mileage submitted by the States had not only not grown at all since the beginning of the fiscal year; it had been actually diminished as a result of the withdrawal and substitution of projects, so that the total mileage proposed was only 35,379 miles as compared with the 35,402 miles of four months previously. Immediately upon the approval of the new act the initiation of projects took on new life and in the months of March and June reached the unprecedented total of 1,250 miles a month. At the close of the year the submitted mileage is 39,940 miles, 4,538 miles greater than at the close of the preceding fiscal year.

At the close of the preceding fiscal year projects completed aggregated 7,469 miles and there were 17,978 miles under construction, which were estimated as 50 per cent complete. In one year the completed mileage has grown to 17,716 miles, an increase of more than 10,000 miles, and there still remain under construction 14,513 miles which are estimated as 56 per cent complete. The Federal aid earned by the States on completed and uncompleted projects amounts to $194,560,135, of which $166,911,552 have actually been paid.

The total length of projects in all stages, including those which have been completed and those which are in the stages preliminary to construction, is 39,940 miles. Of this mileage, as stated above, 17,716 miles are completed, 14,513 are under construction, and the balance of 7,711 miles is in the preconstruction stage.

The roads brought to completion during the year average over 200 miles for each State. The greatest increase in completed mileage is in Texas, which has added during the year 933 miles to her completed highway. But Texas owes its leading position largely to its size. The States of Arkansas, Georgia, Iowa, Minnesota, and North Carolina, each with an increase of more than 500 miles, and Montana and Wisconsin, with more than 400 miles, made notable advances toward the goal of a completed highway system.

A number of smaller States, such as Louisiana, Maryland, Massachusetts, and Rhode Island, made very substantial increases in proportion to their size, though some of them were prevented from adding as largely to their mileage as they otherwise would by the fact that they had practically expended all the Federal aid available to them before the passage of the Federal highway act and were unable to initiate new projects. This is notably the case with respect to Delaware, which has not increased its completed mileage at all.

The largest payment of Federal aid during the year also went to Texas, which received from the Government $5,915,046 and earned nearly two and a half million more. Other large payments were made to Illinois, Iowa, Ohio, and Pennsylvania, each of which received from four to five million dollars or more during the year.

Something of the magnitude of the task that is being accomplished is in these significant totals. The mere size of the job and the celerity with which it has been carried forward are made clear in fullness of detail in the statistical tables which are printed on other pages.

### THE VALUE OF THE ROADS.

But merely to say that this year has added 10,000 miles to the previously existing mileage conveys no adequate sense of the far-reaching effects of the work that is being done. The 10,000 miles completed represent something more than the equivalent of three transcontinental roads. They are not transcontinental roads. They are not even connected roads, though as the work continues they will be connected; but each separate project is to some community a new opportunity, a means of bettering, in some respects, the economic and social status of the community, and together they form the links which, eventually united, will constitute a new means of transportation, no less important to the country as a whole than that offered by the railroads.

What they mean to the localities in which they are constructed can only be told by example. For example, then, there is the Federal-aid road from Helena in Arkansas to Old Town, 17 miles away on the Mississippi. When, last spring, the river rose and threatened to spread over the whole of that low country in Arkansas in a destructive flood, word came to Helena that the levee at Old Town was about to break. The situation was critical. A few hours' delay and thousands of acres of rich farming land would be flooded. Helena was the only source of aid and many men with tools and material were needed. Every available motor vehicle was pressed into service and over 600 men, equipped for the work ahead were in a short time speeding over the new road to the levee. They arrived in the nick of time and by almost superhuman efforts dammed back the rising waters. There is no question in the minds of the people of Old Town and Helena about the value of their new Federal-aid road. They are sure that if they had been dependent upon the old road the help so desperately needed could not have reached the levee in time.

Out in Arizona there is another road that is drawing near to completion. It will connect Superior and Miami, two of the largest and most important towns in the copper country. By the old road the distance between them is a full hundred miles. The new road, tunneled in places through solid rock, will shorten the distance by 80 miles.

In Alabama the plans have been drawn for a new Federal-aid project between Ariton and Clayton. The old road between these towns, which are 25 miles apart, crosses the railroad 14 times in that distance. By a piece of excellent engineering 13 of these crossings have been eliminated, and the one remaining is not dangerous.

In Maryland there was one particular curve on the road from Baltimore to Washington so deadly that it was known throughout the State as "Dead Man's Curve." It was what is known as a reverse curve, there was a heavy grade, and high banks obscured the view from both directions. Hundreds of automobiles had been wrecked because of this curve and there was a record of 35 deaths charged against it. The dangerous condition has now been eliminated by the State with Federal aid, and though it was necessary to spend $17,000 in less than a quarter of a mile, none of those who use the road need to be convinced of the wisdom of the expenditure or the value of the improvemment.

In Illinois the Lincoln Highway has been improved for almost the entire distance across the State, from Chicago to Clinton, with Federal aid. So also has been the old national pike from Marshall at the eastern line to St. Louis at the west. Another trans-State road has been built from Chicago to Rock Island, with a branch southward to St. Louis; and a branch from the old national pike runs southward to the bridge at Cairo. Together these roads form the principal trunk lines of the State, and they have been improved almost entirely as Federal-aid projects. There can be no doubt in the minds of the people of Illinois as to the value of this work, which has given them in the brief space of six years a major network of magnificent highways covering the whole State.

A number of important bridge projects have been brought to completion during the year, among them the bridge over the Missouri River between Bismarck and Mandan, N. Dak. This is the only highway bridge over the river north of Yankton and is one of the notable bridge structures recently built in this country. Another bridge of importance has been completed over the Apalachicola River at River Junction, Fla., the only highway bridge across that stream south of Columbus, Ga. In Missouri there has long been need for several bridges to span the lower Missouri and connect the two sections into which the State is divided by the river. The lack of these crossings has been a most serious obstacle to communication, and the proposals submitted by the State for the construction of several bridges just before the close of the fiscal year are therefore of great interest to the people of the State.

These are merely instances of hundreds and thousands of improvements in every State, each of which is a significant forward step in the local community and the sum total of which will eventually mean to the United States all the difference between the costly, unsafe, and intermittent highway transportation of the past and the unhampered, economical, convenient, and safe transportation which the developing system of roads will eventually make possible in all sections.

### THE CHARACTER OF THE ROADS.

The Federal highway act imposes only one condition upon the character of the roads to be built under it that has not obtained in the work under the earlier Federal-aid road act. That condition is that the primary or interstate roads shall have a width of surfacing of at least 18 feet, unless certain well-defined conditions render such a width impracticable. This provision of the act has been strictly adhered to in the approval of projects submitted since the passage of the act and no difficulty is anticipated in the future.

The principles that have governed the character of the roads built, as to grade and drainage and type of surfacing, are not affected by the new act, and the bureau is continuing to approve surfaces of all types, the only condition being that the type selected shall be consistent with the traffic requirements under the climatic and soil conditions prevailing.

The division of the roads of the system into primary and secondary classes does not imply that all roads of the primary class are to be surfaced with a higher type of material than the secondary roads. On the contrary, it is to be anticipated that primary roads in some sections of the country, notably in many of the Southern and Western States, will not require a higher type of surface than the secondary roads in other sections—for example, New England and the industrial East.

In many instances it has been found advisable to grade and drain a road and delay an expensive pavement until a later time. This policy will be continued under the same conditions; that is, when the volume of traffic at the time of original construction is not large enough to require any better surface than can be built of selected soil, sand-clay, or gravel, when financial considerations require that the expense of a pavement be deferred, and when, as in the light of past experience it has often been found advisable, a delay to allow the subgrade to become stable is believed to be necessary. In such cases the plan will be, as it has been in the past, to so design and construct the grades and drainage structures and whatever temporary surfacing that is applied, that any additions or subsequent improvements can be made without loss of prior investment.

The increasing number of accidents at highway grade crossings has become a matter of grave concern, and has led to the adoption of a policy looking to the elimination of such dangerous crossings wherever practicable on Federal-aid roads. The policy, which has met with the generous support of the States, is that all existing grade crossings on the Federal-aid highway system shall be classified for priority of elimination by agreement between the bureau and the State highway departments, and the improvements shall be carried out as rapidly as practicable.

## ORGANIZATION CHANGES.

Changes in the organization during the year have been relatively unimportant. The most important was a reduction in the number of field districts from 13 to 12. One district engineer resigned to accept a position as a State highway engineer at considerable increase in salary.

In general, the personnel turnover during the year was less than in the two or three years previous and involved the loss of fewer of the bureau's more valuable employees.

The following table shows the relation of the turnover during 1922 to that of the previous year:

| | 1921 | 1922 |
|---|---|---|
| District engineers | | 1 |
| Engineers of senior highway grade | 10 | 11 |
| Engineers of highway grade | 7 | 4 |
| Engineers of junior grade | 1 | 1 |
| Clerks | 45 | 28 |

TABLE 1.—*Apportionments of Federal aid to States by fiscal years.*

| State. | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | Total apportionments, years 1917-1922, inclusive. | Federal aid paid on projects completed and paid for. | Apportionment balances as of June 30, 1922. |
|---|---|---|---|---|---|---|---|---|---|
| Alabama | $104, 148. 90 | $208, 297. 80 | $1, 363, 720. 57 | $1, 995, 501. 80 | $2, 104, 883. 51 | $1, 553, 420. 67 | $7, 329, 973. 25 | $1, 471, 037. 95 | $5, 858, 935. 30 |
| Arizona | 68, 513. 52 | 137, 027. 04 | 890, 584. 16 | 1, 301, 582. 81 | 1, 373, 644. 16 | 1, 053, 281. 44 | 4, 824, 633. 13 | 1, 733, 789. 06 | 3, 090, 844. 07 |
| Arkansas | 82, 689. 10 | 165, 378. 20 | 1, 090, 247. 99 | 1, 596, 436. 09 | 1, 685, 178. 09 | 1, 254, 142. 20 | 5, 874, 071. 67 | 1, 714, 903. 00 | 4, 159, 168. 67 |
| California | 151, 063. 92 | 302, 127. 84 | 1, 980, 415. 53 | 2, 896, 071. 77 | 3, 054, 675. 51 | 2, 462, 098. 53 | 10, 846, 453. 10 | 1, 423, 937. 46 | 9, 422, 515. 64 |
| Colorado | 83, 690. 14 | 167, 380. 28 | 1, 124, 849. 83 | 1, 648, 384. 72 | 1, 755, 759. 17 | 1, 341, 175. 69 | 6, 121, 239. 83 | 1, 631, 345. 69 | 4, 489, 894. 14 |
| Connecticut | 31, 090. 44 | 62, 180. 88 | 399, 281. 11 | 583, 422. 84 | 613, 349. 43 | 480, 897. 78 | 2, 170, 222. 48 | 163, 910. 78 | 2, 006, 311. 70 |
| Delaware | 8, 184. 37 | 16, 368. 74 | 105, 796. 45 | 154, 630. 46 | 162, 674. 81 | 365, 625. 00 | 813, 279. 83 | 393, 654. 83 | 419, 625. 00 |
| Florida | 55, 976. 27 | 111, 952. 54 | 744, 521. 08 | 1, 090, 214. 67 | 1, 147, 447. 92 | 886, 825. 69 | 4, 036, 938. 17 | 29, 700. 63 | 4, 007, 237. 54 |
| Georgia | 134, 329. 48 | 268, 658. 96 | 1, 749, 954. 20 | 2, 557, 485. 02 | 2, 697, 150. 96 | 1, 997, 957. 58 | 9, 405, 536. 20 | 5, 636, 278. 70 | 3, 769, 257. 50 |
| Idaho | 60, 463. 50 | 120, 927. 00 | 792, 980. 82 | 1, 159, 967. 61 | 1, 226, 049. 93 | 938, 536. 68 | 4, 298, 925. 54 | 3, 028, 399. 88 | 1, 270, 525. 66 |
| Illinois | 220, 926. 23 | 441, 852. 46 | 2, 843, 874. 13 | 4, 152, 546. 24 | 4, 365, 067. 91 | 3, 246, 281. 07 | 15, 270, 548. 04 | 10, 668, 902. 80 | 4, 601, 645. 24 |
| Indiana | 135, 747. 62 | 271, 495. 24 | 1, 756, 149. 60 | 2, 564, 846. 88 | 2, 687, 053. 27 | 1, 958, 855. 41 | 9, 374, 148. 02 | 1, 676, 894. 90 | 7, 697, 253. 12 |
| Iowa | 146, 175. 60 | 292, 351. 20 | 1, 877, 699. 81 | 2, 741, 787. 79 | 2, 881, 328. 74 | 2, 102, 872. 74 | 10, 042, 215. 88 | 3, 511, 878. 62 | 6, 530, 337. 26 |
| Kansas | 143, 207. 40 | 286, 414. 80 | 1, 865, 445. 80 | 2, 728, 996. 45 | 2, 871, 244. 62 | 2, 102, 281. 51 | 9, 997, 590. 58 | 1, 892, 280. 87 | 8, 105, 309. 71 |
| Kentucky | 97, 471. 91 | 194, 943. 82 | 1, 269, 849. 80 | 1, 856, 043. 83 | 1, 951, 755. 43 | 1, 417, 178. 68 | 6, 787, 243. 47 | 1, 224, 965. 71 | 5, 562, 277. 76 |
| Louisiana | 67, 474. 66 | 134, 949. 32 | 884, 484. 31 | 1, 293, 385. 15 | 1, 362, 231. 13 | 996, 989. 64 | 4, 739, 514. 21 | 1, 386, 187. 59 | 3, 353, 326. 62 |
| Maine | 48, 451. 50 | 96, 903. 00 | 626, 038. 97 | 914, 339. 94 | 960, 230. 16 | 695, 160. 25 | 3, 341, 123. 82 | 857, 280. 65 | 2, 483, 843. 17 |
| Maryland | 44, 047. 22 | 88, 094. 44 | 565, 608. 45 | 826, 000. 35 | 866, 998. 61 | 640, 629. 01 | 3, 031, 378. 08 | 2, 272, 317. 90 | 759, 060. 18 |
| Massachusetts | 73, 850. 95 | 147, 701. 90 | 958, 145. 15 | 1, 400, 078. 26 | 1, 472, 788. 83 | 1, 096, 176. 04 | 5, 148, 741. 13 | 1, 759, 714. 95 | 3, 389, 026. 18 |
| Michigan | 145, 783. 72 | 291, 567. 44 | 1, 882, 570. 18 | 2, 749, 706. 24 | 2, 891, 667. 97 | 2, 249, 532. 43 | 10, 210, 827. 98 | 1, 680, 192. 96 | 8, 530, 635. 02 |
| Minnesota | 142, 394. 06 | 284, 788. 12 | 1, 846, 639. 92 | 2, 699, 471. 59 | 2, 842, 089. 33 | 2, 123, 597. 07 | 9, 938, 980. 09 | 4, 061, 832. 60 | 5, 877, 147. 49 |
| Mississippi | 88, 905. 84 | 177, 811. 68 | 1, 168, 239. 88 | 1, 709, 027. 72 | 1, 807, 557. 17 | 1, 294, 906. 22 | 6, 246, 448. 51 | 1, 453, 631. 39 | 4, 792, 817. 12 |
| Missouri | 169, 720. 41 | 339, 440. 82 | 2, 203, 918. 08 | 3, 221, 096. 80 | 3, 387, 899. 60 | 2, 448, 128. 62 | 11, 770, 204. 33 | 1, 370, 645. 18 | 10, 399, 559. 15 |
| Montana | 98, 287. 19 | 196, 574. 38 | 1, 297, 988. 03 | 1, 898, 987. 58 | 2, 006, 990. 13 | 1, 546, 885. 82 | 7, 045, 713. 13 | 2, 591, 706. 30 | 4, 454, 006. 83 |
| Nebraska | 106, 770. 81 | 213, 541. 62 | 1, 386, 087. 32 | 2, 026, 619. 93 | 2, 133, 741. 98 | 1, 581, 189. 50 | 7, 447, 951. 16 | 499, 522. 90 | 6, 948, 428. 26 |
| Nevada | 64, 398. 30 | 128, 796. 60 | 836, 163. 28 | 1, 221, 573. 57 | 1, 276, 344. 43 | 953, 436. 78 | 4, 480, 712. 96 | 877, 660. 30 | 3, 603, 052. 66 |
| New Hampshire | 20, 996. 62 | 41, 993. 24 | 270, 420. 49 | 394, 839. 71 | 414, 838. 93 | 365, 625. 00 | 1, 508, 713. 99 | 906, 518. 19 | 602, 195. 80 |
| New Jersey | 59, 212. 68 | 118, 425. 36 | 771, 408. 02 | 1, 128, 696. 51 | 1, 187, 556. 45 | 942, 870. 95 | 4, 208, 169. 97 | 1, 161, 457. 31 | 3, 046, 712. 66 |
| New Mexico | 78, 737. 81 | 157, 475. 62 | 1, 037, 420. 34 | 1, 517, 692. 99 | 1, 598, 467. 85 | 1, 189, 823. 34 | 5, 579, 617. 95 | 890, 449. 48 | 4, 689, 168. 47 |
| New York | 250, 720. 27 | 501, 440. 54 | 3, 237, 630. 60 | 4, 727, 117. 15 | 4, 971, 893. 11 | 3, 696, 447. 97 | 17, 385, 249. 64 | 1, 686, 215. 91 | 15, 699, 033. 73 |
| North Carolina | 114, 381. 92 | 228, 763. 84 | 1, 482, 533. 93 | 2, 165, 957. 19 | 2, 279, 053. 80 | 1, 709, 333. 90 | 7, 980, 024. 58 | 2, 605, 098. 76 | 5, 374, 925. 82 |
| North Dakota | 76, 143. 06 | 152, 286. 12 | 997, 946. 19 | 1, 459, 884. 53 | 1, 536, 227. 80 | 1, 164, 714. 42 | 5, 387, 202. 12 | 639, 879. 22 | 4, 747, 322. 90 |
| Ohio | 186, 905. 42 | 373, 810. 84 | 2, 412, 505. 91 | 3, 523, 478. 73 | 3, 706, 246. 81 | 2, 823, 004. 05 | 13, 025, 951. 76 | 5, 653, 904. 56 | 7, 372, 047. 20 |
| Oklahoma | 115, 139. 00 | 230, 278. 00 | 1, 499, 544. 83 | 2, 190, 805. 44 | 2, 302, 478. 33 | 1, 752, 339. 44 | 8, 090, 585. 04 | 1, 117, 967. 15 | 6, 972, 617. 89 |
| Oregon | 78, 687. 37 | 157, 374. 74 | 1, 023, 791. 84 | 1, 496, 172. 28 | 1, 576, 152. 03 | 1, 182, 663. 90 | 5, 514, 842. 16 | 4, 032, 957. 06 | 1, 481, 885. 10 |
| Pennsylvania | 230, 644. 17 | 461, 288. 34 | 2, 986, 221. 62 | 4, 362, 544. 11 | 4, 591, 946. 05 | 3, 398, 953. 97 | 16, 031, 598. 26 | 8, 372, 167. 23 | 7, 659, 431. 03 |
| Rhode Island | 11, 665. 71 | 23, 331. 42 | 151, 503. 33 | 221, 408. 80 | 233, 256. 87 | 365, 625. 00 | 1, 006, 791. 13 | 550, 080. 40 | 456, 710. 73 |
| South Carolina | 71, 807. 64 | 143, 615. 28 | 932, 311. 14 | 1, 362, 864. 40 | 1, 436, 019. 04 | 1, 061, 237. 34 | 5, 007, 854. 84 | 1, 853, 012. 58 | 3, 154, 842. 26 |
| South Dakota | 80, 946. 02 | 161, 892. 04 | 1, 053, 896. 27 | 1, 540, 369. 27 | 1, 615, 779. 44 | 1, 204, 060. 31 | 5, 656, 943. 35 | 699, 618. 84 | 4, 957, 324. 51 |
| Tennessee | 114, 153. 48 | 228, 306. 96 | 1, 472, 767. 00 | 2, 150, 996. 64 | 2, 261, 913. 90 | 1, 647, 692. 24 | 7, 875, 830. 22 | 586, 897. 44 | 7, 288, 932. 78 |
| Texas | 291, 927. 81 | 583, 855. 62 | 3, 803, 206. 07 | 5, 559, 816. 81 | 5, 861, 598. 46 | 4, 425, 172. 41 | 20, 525, 577. 18 | 4, 727, 939. 21 | 15, 797, 637. 97 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Utah | 56,950.15 | 113,900.30 | 738,355.27 | 1,078,425.00 | 1,129,575.66 | 849,417.21 | 3,966,623.59 | 266,499.90 | 3,700,123.69 |
| Vermont | 22,844.47 | 45,688.94 | 294,116.61 | 429,376.62 | 450,077.09 | 365,625.00 | 1,607,728.73 | 263,963.82 | 1,343,764.91 |
| Virginia | 99,660.71 | 199,321.42 | 1,290,173.72 | 1,884,900.60 | 1,977,673.83 | 1,456,828.47 | 6,908,558.75 | 1,303,618.26 | 5,604,940.49 |
| Washington | 71,884.28 | 143,768.56 | 938,897.43 | 1,372,497.77 | 1,444,627.79 | 1,103,709.77 | 5,075,385.60 | 3,783,259.11 | 1,292,126.49 |
| West Virginia | 53,270.46 | 106,540.92 | 691,723.00 | 1,010,817.30 | 1,060,152.77 | 802,359.77 | 3,724,864.22 | 1,192,163.78 | 2,532,700.44 |
| Wisconsin | 128,361.07 | 256,722.14 | 1,655,653.72 | 2,418,598.39 | 2,544,945.35 | 1,894,815.86 | 8,899,096.53 | 3,868,465.20 | 5,030,631.33 |
| Wyoming | 61,196.82 | 122,393.64 | 796,718.22 | 1,164,533.65 | 1,233,715.84 | 934,617.63 | 4,313,175.80 | 1,144,090.76 | 3,169,085.04 |
| Total | 4,850,000.00 | 9,700,000.00 | 63,050,000.00 | 92,150,000.00 | 97,000,000.00 | 73,125,000.00 | 339,875,000.00 | 102,318,797.77 | 237,556,202.23 |

NOTE.—In certain of the tables which follow cents and fractions of miles have been dropped, thus departing slightly from the correct figures.

TABLE No. 2.—*Federal aid apportioned and obligated and balances unobligated by States—a statement of current financial obligations.*

| State. | Apportionment balances as of June 30, 1922. | Federal aid obligated by current project statements. | Federal aid obligated by current project agreements. | Total Federal aid obligated. | Balance of apportionment unobligated. |
|---|---|---|---|---|---|
| Alabama | $5,858,935 | $2,031,344 | $3,306,897 | $5,338,241 | $520,694 |
| Arizona | 3,090,844 | 972,613 | 1,583,128 | 2,555,741 | 535,103 |
| Arkansas | 4,159,169 | 775,225 | 2,839,699 | 3,614,924 | 544,245 |
| California | 9,422,516 | 1,887,868 | 5,726,397 | 7,614,265 | 1,808,251 |
| Colorado | 4,489,894 | 1,665,267 | 2,128,714 | 3,793,981 | 695,913 |
| Connecticut | 2,006,312 | 289,600 | 1,140,138 | 1,429,738 | 576,574 |
| Delaware | 419,625 | 52,000 | 360,000 | 412,000 | 7,625 |
| Florida | 4,007,238 | 358,368 | 2,735,705 | 3,094,073 | 913,165 |
| Georgia | 3,769,257 | 1,247,128 | 1,832,992 | 3,080,120 | 689,137 |
| Idaho | 1,270,526 | 638,109 | 194,207 | 832,316 | 438,210 |
| Illinois | 4,601,645 | 2,456,279 | 756,650 | 3,212,929 | 1,388,716 |
| Indiana | 7,697,253 | 2,927,193 | 3,213,178 | 6,140,371 | 1,556,882 |
| Iowa | 6,530,337 | 1,366,350 | 5,081,711 | 6,448,061 | 82,276 |
| Kansas | 8,105,310 | 716,065 | 6,043,376 | 6,759,441 | 1,345,869 |
| Kentucky | 5,562,278 | 637,020 | 3,442,519 | 4,079,539 | 1,482,739 |
| Louisiana | 3,353,327 | 232,000 | 2,241,386 | 2,473,386 | 879,941 |
| Maine | 2,483,843 | 584,291 | 1,772,653 | 2,356,944 | 126,899 |
| Maryland | 759,060 | 440,448 | 270,218 | 710,666 | 48,394 |
| Massachusetts | 3,389,026 | 1,675,966 | 1,540,016 | 3,215,982 | 173,044 |
| Michigan | 8,530,635 | 3,206,050 | 4,911,662 | 8,117 712 | 412,923 |
| Minnesota | 5,877,147 | 1,140,122 | 4,479,019 | 5,619,141 | 258,006 |
| Mississippi | 4,792,817 | 403,108 | 2,891,667 | 3,294,775 | 1,498,042 |
| Missouri | 10,399,559 | 1,833,794 | 5,828,107 | 7,661,901 | 2,737,658 |
| Montana | 4,454,007 | 1,378,820 | 1,503,568 | 2,882,388 | 1,571,619 |
| Nebraska | 6,948,428 | 707,645 | 4,612,125 | 5,319,770 | 1,628,658 |
| Nevada | 3,603,053 | 295,221 | 1,635,737 | 1,930,958 | 1,672,095 |
| New Hampshire | 602,196 | 201,124 | 214,074 | 415,198 | 186,998 |
| New Jersey | 3,046,713 | 591,049 | 2,306,381 | 2,897,430 | 149,283 |
| New Mexico | 4,689,168 | 879,353 | 2,393,182 | 3,272,535 | 1,416,633 |
| New York | 15,699,034 | 3,838,804 | 8,710,153 | 12,548,957 | 3,150,077 |
| North Carolina | 5,374,926 | 867,541 | 3,529,573 | 4,397,114 | 977,812 |
| North Dakota | 4,747,323 | 679,886 | 2,846,673 | 3,526,559 | 1,220,764 |
| Ohio | 7,372,047 | 3,988,404 | 2,825,101 | 6,813,505 | 558,542 |
| Oklahoma | 6,972,618 | 494,964 | 4,687,573 | 5,182,537 | 1,790,081 |
| Oregon | 1,481,885 | 844,270 | 381,491 | 1,225,761 | 256,124 |
| Pennsylvania | 7,659,431 | 2,112,180 | 5,397,823 | 7,510,003 | 149,428 |
| Rhode Island | 456,711 | 105,924 | 87,331 | 193,255 | 263,456 |
| South Carolina | 3,154,842 | 686,768 | 1,897,731 | 2,584,499 | 570,343 |
| South Dakota | 4,957,324 | 551,685 | 3,298,840 | 3,850,525 | 1,106,799 |
| Tennessee | 7,288,933 | 1,752,010 | 5,332,723 | 7,084,733 | 204,200 |
| Texas | 15,797,638 | 2,766,054 | 10,262,502 | 13,028,556 | 2,769,082 |
| Utah | 3,700,124 | 725,034 | 2,489,929 | 3,214,963 | 485,161 |
| Vermont | 1,343,765 | 205,516 | 702,043 | 907,559 | 436,206 |
| Virginia | 5,604,941 | 1,191,951 | 3,443,468 | 4,635,419 | 969,522 |
| Washington | 1,292,126 | 151,105 | 990,350 | 1,141,455 | 150,67 |
| West Virginia | 2,532,700 | 143,335 | 2,384,759 | 2,528,094 | 4,6066 |
| Wisconsin | 5,030,631 | 1,065.697 | 1,829,348 | 2,895,045 | 2,135,585 |
| Wyoming | 3,169,085 | 978,819 | 1,878,241 | 2,857,060 | 312,02 |
| Total | 237,556,202 | 54,739,367 | 139,960,758 | 194,700,125 | 42,856,077 |

TABLE 3.—*Summary of projects completed and paid for and payments to States by fiscal years.*

| Fiscal year. | Projects completed and paid for. | | | Federal aid paid to States on projects completed and projects under construction. |
|---|---|---|---|---|
| | Mileage. | Federal aid. | Total cost. | |
| 1918 | 12.5 | $112,257 | $258,731 | $425,446 |
| 1919 | 176.8 | 768,472 | 2,124,873 | 2,702,248 |
| 1920 | 716.1 | 3,159,791 | 7,405,000 | 19,593,430 |
| 1921 | 2,898.5 | 18,462,090 | 42,071,405 | 55,974,305 |
| 1922 | 9,550.8 | 79,816,187 | 189,042,424 | 88,216,123 |
| Total | 13,354.7 | 102,318,797 | 240,902,433 | 166,911,552 |

TABLE 4.—*Summary of projects under construction.*

| State. | Number of projects under construction. | Mileage. | Federal aid allotted. | Total estimated cost. | Estimated per cent of completion. |
|---|---|---|---|---|---|
| Alabama | 35 | 395.8 | $2,805,190 | $5,610,380 | 30 |
| Arizona | 14 | 201.5 | 1,630,097 | 3,405,007 | 67 |
| Arkansas | 36 | 406.9 | 1,881,651 | 4,380,105 | 67 |
| California | 37 | 426.9 | 4,808,634 | 9,561,586 | 54 |
| Colorado | 43 | 187.9 | 1,792,073 | 3,492,133 | 65 |
| Connecticut | 4 | 49.4 | 983,108 | 2,575,637 | 61 |
| Delaware | 7 | 24.9 | 342,000 | 857,975 | 20 |
| Florida | 19 | 142.8 | 2,502,976 | 5,186,220 | 46 |
| Georgia | 52 | 375.8 | 1,668,997 | 3,594,881 | 59 |
| Idaho | 4 | 39.7 | 335,283 | 837,022 | 40 |
| Illinois | 7 | 21.7 | 425,622 | 1,022,573 | 76 |
| Indiana | 19 | 168.7 | 3,553,655 | 7,346,606 | 44 |
| Iowa | 61 | 939.9 | 4,134,670 | 9,032,163 | 74 |
| Kansas | 70 | 452.3 | 5,068,213 | 16,384,319 | 56 |
| Kentucky | 29 | 215.7 | 2,661,924 | 5,446,693 | 58 |
| Louisana | 16 | 289.8 | 1,808,032 | 4,121,175 | 85 |
| Maine | 23 | 107.0 | 1,926,552 | 4,019,671 | 72 |
| Maryland | 5 | 16.7 | 178,472 | 356,944 | 15 |
| Massachusetts | 14 | 47.0 | 1,009,150 | 2,606,627 | 35 |
| Michigan | 26 | 291.0 | 3,807,679 | 7,860,263 | 44 |
| Minnesota | 102 | 944.2 | 4,193,887 | 10,704,311 | 65 |
| Mississippi | 34 | 411.2 | 2,616,150 | 5,291,270 | 59 |
| Missouri | 54 | 497.5 | 4,142,183 | 8,981,261 | 42 |
| Montana | 21 | 174.5 | 937,047 | 1,879,005 | 63 |
| Nebraska | 65 | 736.8 | 2,480,669 | 4,994,716 | 90 |
| Nevada | 10 | 73.7 | 577,555 | 840,172 | 50 |
| New Hampshire | 19 | 25.8 | 249,968 | 506,689 | 63 |
| New Jersey | 11 | 43.2 | 862,786 | 2,536,329 | 53 |
| New Mexico | 36 | 536.1 | 1,594,262 | 2,806,830 | 60 |
| New York | 79 | 415.6 | 6,700,165 | 16,861,924 | 36 |
| North Carolina | 16 | 152.2 | 1,241,395 | 2,527,084 | 86 |
| North Dakota | 62 | 721.4 | 2,452,243 | 4,904,630 | 74 |
| Ohio | 38 | 161.0 | 2,138,070 | 6,473,946 | 66 |
| Oklahoma | 22 | 355.6 | 3,827,234 | 9,050,010 | 59 |
| Oregon | 4 | 29.6 | 492,029 | 876,416 | 33 |
| Pennsylvania | 27 | 163.2 | 3,294,760 | 9,992,151 | 57 |
| Rhode Island | 1 | 6.6 | 87,331 | 280,815 | 45 |
| South Carolina | 53 | 425.6 | 1,884,915 | 3,980,160 | 58 |
| South Dakota | 54 | 611.6 | 2,705,610 | 5,426,238 | 60 |
| Tennessee | 33 | 387.2 | 5,417,445 | 10,905,566 | 45 |
| Texas | 107 | 1,494.5 | 7,890,444 | 23,577,437 | 60 |
| Utah | 14 | 231.6 | 1,942,835 | 3,509,701 | 57 |
| Vermont | 9 | 23.7 | 336,514 | 673,029 | 45 |
| Virginia | 36 | 196.2 | 2,164,093 | 4,366,081 | 50 |
| Washington | 7 | 17.4 | 343,100 | 744,012 | 40 |
| West Virginia | 47 | 160.3 | 1,915,892 | 4,452,304 | 71 |
| Wisconsin | 93 | 459.5 | 2,291,227 | 5,756,101 | 72 |
| Wyoming | 37 | 256.1 | 1,885,970 | 3,673,645 | 62 |
| Total | 1,612 | 14,513.3 | 109,989,757 | 254,269,813 | 56 |

TABLE 5.—*Summary by States of completed projects and payments to States.*

| State. | Number of projects. | Mileage. | Federal aid. | Total estimated cost. | Federal aid paid to States on projects completed and projects under construction. |
|---|---|---|---|---|---|
| Alabama | 56 | 351.0 | $1,680,369 | $3,535,684 | $2,023,403 |
| Arizona | 33 | 191.5 | 1,819,701 | 3,688,492 | 2,706,621 |
| Arkansas | 56 | 576.5 | 2,538,751 | 7,073,703 | 3,291,482 |
| California | 39 | 305.5 | 3,122,532 | 6,524,043 | 3,856,186 |
| Colorado | 75 | 275.4 | 2,078,997 | 4,352,284 | 2,680,248 |
| Connecticut | 3 | 24.2 | 320,940 | 661,543 | 809,822 |
| Delaware | 6 | 28.1 | 393,655 | 1,615,761 | 461,548 |
| Florida | 9 | 48.7 | 369,179 | 775,880 | 810,235 |
| Georgia | 152 | 807.2 | 5,949,842 | 13,123,485 | 6,678,707 |
| Idaho | 43 | 409.5 | 3,127,957 | 6,598,084 | 3,145,837 |
| Illinois | 210 | 721.0 | 10,999,931 | 24,186,147 | 11,093,043 |
| Indiana | 22 | 121.3 | 2,265,184 | 4,667,573 | 2,445,878 |
| Iowa | 59 | 677.4 | 4,588,041 | 12,155,894 | 5,604,936 |
| Kansas | 48 | 253.8 | 2,952,506 | 9,491,899 | 4,597,477 |
| Kentucky | 34 | 216.9 | 2,048,574 | 4,529,401 | 2,838,897 |
| Louisiana | 39 | 389.1 | 1,990,526 | 4,437,335 | 3,083,184 |
| Maine | 12 | 68.2 | 909,662 | 1,923,888 | 1,861,223 |
| Maryland | 65 | 171.0 | 2,346,039 | 4,953,162 | 2,278,187 |
| Massachusetts | 56 | 146.9 | 2,327,356 | 5,685,220 | 2,066,810 |
| Michigan | 47 | 272.7 | 3,375,014 | 7,247,699 | 4,477,186 |
| Minnesota | 117 | 1,236.9 | 4,728,687 | 12,141,988 | 7,162,927 |
| Mississippi | 43 | 351.0 | 1,850,790 | 3,871,032 | 2,784,496 |
| Missouri | 41 | 247.4 | 1,898,251 | 4,384,894 | 3,227,749 |
| Montana | 83 | 556.7 | 2,972,263 | 6,051,011 | 3,414,071 |
| Nebraska | 52 | 888.8 | 2,276,798 | 4,803,401 | 3,364,816 |
| Nevada | 25 | 182.0 | 1,292,345 | 2,785,736 | 1,258,303 |
| New Hampshire | 114 | 119.8 | 917,114 | 1,903,892 | 1,016,026 |
| New Jersey | 24 | 82.3 | 1,392,917 | 3,799,100 | 1,464,777 |
| New Mexico | 32 | 390.9 | 1,689,027 | 3,355,046 | 2,214,206 |
| New York | 35 | 131.8 | 2,134,756 | 4,900,529 | 3,403,340 |
| North Carolina | 103 | 773.9 | 4,893,277 | 10,710,828 | 5,308,161 |
| North Dakota | 50 | 492.0 | 1,161,645 | 2,428,168 | 2,679,976 |
| Ohio | 123 | 512.9 | 5,975,335 | 17,650,894 | 7,034,570 |
| Oklahoma | 30 | 117.7 | 1,706,466 | 3,746,523 | 3,550,571 |
| Oregon | 45 | 462.5 | 4,096,527 | 9,163,424 | 4,250,034 |
| Pennsylvania | 120 | 545.5 | 10,506,750 | 27,379,257 | 11,244,455 |
| Rhode Island | 11 | 32.0 | 550,080 | 1,284,455 | 575,853 |
| South Carolina | 70 | 424.3 | 1,977,733 | 4,208,353 | 2,679,077 |
| South Dakota | 43 | 300.4 | 1,385,090 | 2,868,349 | 2,573,570 |
| Tennessee | 12 | 107.7 | 1,309,461 | 2,693,234 | 2,757,207 |
| Texas | 155 | 1,615.6 | 7,351,876 | 18,395,478 | 9,637,560 |
| Utah | 10 | 59.5 | 567,342 | 1,150,587 | 1,135,907 |
| Vermont | 19 | 41.9 | 543,083 | 1,099,730 | 564,869 |
| Virginia | 74 | 342.1 | 2,800,056 | 5,723,128 | 3,323,766 |
| Washington | 80 | 362.3 | 3,915,909 | 8,450,317 | 3,929,289 |
| West Virginia | 63 | 166.2 | 1,486,449 | 3,321,085 | 2,431,279 |
| Wisconsin | 181 | 702.7 | 3,963,579 | 10,744,919 | 4,964,542 |
| Wyoming | 57 | 413.7 | 1,530,842 | 3,223,989 | 2,149,245 |
| Total | 2,876 | 17,716.4 | 132,079,204 | 309,466,524 | 166,911,552 |

TABLE 6.—*Summary by types of projects completed and final payments made.*

| State. | Graded and drained. |  |  | Sand-clay. |  |  | Gravel. |  |  | Water-bound macadam. |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | $46,827.25 | $23,413.62 | 3.1 | $924,773.01 | $458,878.57 | 194.9 | $890,152.59 | $128,488.05 | 97.1 |  |  |  |
| Arizona | 386,333.87 | 186,974.42 | 36.7 |  |  |  | 1,146,906.95 | 549,722.42 | 84.8 |  |  |  |
| Arkansas |  |  |  |  |  |  | 1,775,877.59 | 758,372.88 | 278.7 | $159,320.97 | $41,138.00 | 18.3 |
| California | 935,162.55 | 416,260.04 | 65.4 |  |  |  |  |  |  |  |  |  |
| Colorado | 831,626.64 | 364,186.76 | 95.0 | 224,068.87 | 105,352.49 | 36.2 | 461,676.98 | 225,279.26 | 42.1 |  |  |  |
| Connecticut |  |  |  |  |  |  |  |  |  |  |  |  |
| Delaware |  |  |  |  |  |  |  |  |  |  |  |  |
| Florida |  |  |  | 69,466.31 | 29,700.63 | 15.6 |  |  |  |  |  |  |
| Georgia | 618,312.60 | 304,539.87 | 50.9 | 4,058,614.31 | 1,845,190.89 | 487.5 | 907,200.19 | 420,986.20 | 49.2 | 40,061.03 | 20,029.52 | 3.1 |
| Idaho | 1,633,671.80 | 749,487.65 | 106.0 | 193,272.34 | 96,636.17 | 18.6 | 2,841,780.56 | 1,402,734.44 | 243.7 | 70,796.49 | 20,000.00 | 4.3 |
| Illinois | 3,251,320.78 | 877,880.78 | 131.9 |  |  |  |  |  |  |  |  |  |
| Indiana |  |  |  |  |  |  |  |  |  |  |  |  |
| Iowa | 1,511,197.91 | 527,110.91 | 239.9 |  |  |  | 924,656.57 | 339,733.08 | 111.1 |  |  |  |
| Kansas | 77,291.36 | 31,505.66 | 7.3 |  |  |  | 212,424.41 | 101,042.71 | 13.0 | 90,617.76 | 41,516.00 | 4.5 |
| Kentucky | 1,058,739.95 | 505,865.43 | 77.4 |  |  |  |  |  |  | 483,657.78 | 178,017.88 | 21.6 |
| Louisiana | 25,626.96 | 11,332.40 | 7.4 |  |  |  | 2,895,055.52 | 1,252,597.86 | 266.9 | 99,622.92 | 48,516.36 | 3.2 |
| Maine |  |  |  |  |  |  | 409,177.06 | 192,159.20 | 21.1 |  |  |  |
| Maryland | 42,768.57 | 21,162.44 | 2.6 |  |  |  | 373,168.68 | 185,984.52 | 23.9 | 9,218.84 | 2,920.00 | .1 |
| Massachusetts |  |  |  |  |  |  |  |  |  | 45,375.31 | 22,687.65 | 3.4 |
| Michigan |  |  |  |  |  |  | 977,379.45 | 446,118.39 | 73.4 | 133,857.74 | 58,754.15 | 8.5 |
| Minnesota | 632,696.93 | 271,533.42 | 52.0 |  |  |  | 6,943,545.85 | 2,716,858.16 | 1,011.2 |  |  |  |
| Mississippi | 503,972.37 | 250,496.87 | 81.8 |  |  |  | 2,214,875.95 | 1,026,719.96 | 209.7 |  |  |  |
| Missouri | 139,953.42 | 69,855.86 | 32.7 |  |  |  | 745,935.14 | 334,797.21 | 97.9 |  |  |  |
| Montana | 963,192.33 | 480,136.09 | 131.7 |  |  |  | 2,568,570.59 | 1,259,411.12 | 288.8 | 111,117.95 | 55,558.97 | 16.0 |
| Nebraska | 445,159.91 | 198,278.17 | 119.4 | 39,004.24 | 19,502.12 | 3.3 | 127,031.80 | 61,769.15 | 30.5 |  |  |  |
| Nevada | 367,010.13 | 167,575.57 | 31.3 |  |  |  | 457,710.67 | 217,551.87 | 61.8 |  |  |  |
| New Hampshire |  |  |  |  |  |  | 971,951.51 | 469,350.95 | 68.5 | 145,550.73 | 70,816.37 | 13.9 |
| New Jersey |  |  |  |  |  |  | 23,414.40 | 4,822.00 | 3.4 |  |  |  |
| New Mexico | 65,694.01 | 32,816.48 | 24.1 | 50,075.54 | 24,921.58 | 5.1 | 1,072,105.91 | 534,351.33 | 134.2 |  |  |  |
| New York |  |  |  |  |  |  |  |  |  |  |  |  |
| North Carolina | 277,043.37 | 133,906.79 | 32.2 | 2,101,244.20 | 933,246.77 | 253.0 | 210,352.41 | 99,732.02 | 39.8 |  |  |  |
| North Dakota | 1,098,563.02 | 524,455.19 | 289.3 | 13,430.75 | 6,715.37 | .5 | 96,508.69 | 46,059.90 | 15.8 |  |  |  |
| Ohio |  |  |  |  |  |  |  |  |  | 965,324.72 | 395,440.50 | 39.7 |
| Oklahoma |  |  |  | 41,222.46 | 20,282.73 | 1.6 | 815,089.48 | 401,230.64 | 48.9 |  |  |  |
| Oregon | 1,619,265.56 | 704,678.91 | 96.8 |  |  |  | 4,056,216.28 | 1,862,658.39 | 258.5 | 378,760.43 | 171,930.02 | 25.6 |
| Pennsylvania |  |  |  |  |  |  |  |  |  |  |  |  |
| Rhode Island |  |  |  |  |  |  |  |  |  |  |  |  |
| South Carolina |  |  |  | 2,226,986.31 | 1,052,773.21 | 319.8 | 325,150.72 | 156,100.25 | 36.5 |  |  |  |
| South Dakota | 366,538.52 | 181,828.47 | 55.3 |  |  |  | 959,798.90 | 470,872.21 | 99.3 |  |  |  |
| Tennessee |  |  |  |  |  |  | 34,648.64 | 17,071.32 | 2.9 | 232,784.16 | 116,392.08 | 12.3 |

TABLE 6.—*Summary by types of projects completed and final payments made*—Continued.

| State. | Graded and drained. | | | Sand-clay. | | | Gravel. | | | Water-bound macadam. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Texas | $474, 766. 59 | $194, 157. 94 | 111. 5 | $201, 345. 55 | $73, 436. 74 | 27. 8 | $5, 774, 095. 06 | $2, 316, 538. 81 | 760. 8 | $1, 366, 661. 62 | $613, 651. 01 | 136. 6 |
| Utah | 15, 539. 48 | 7, 769. 74 | . 4 | | | | | | | 67, 845. 60 | 30, 670. 22 | 9. 3 |
| Vermont | | | | | | | 184, 586. 27 | 89, 653. 04 | 10. 1 | 34, 248. 47 | 14, 388. 33 | 7 |
| Virginia | | | | 472, 497. 31 | 226, 828. 00 | 74. 2 | 163, 234. 13 | 78, 108. 03 | 12. 7 | 490, 210. 56 | 236, 686. 93 | 33. 9 |
| Washington | 626, 383. 45 | 279, 284. 40 | 24. 5 | | | | 2, 940, 301. 57 | 1, 428, 617. 06 | 207. 6 | | | |
| West Virginia | 645, 765. 13 | 294, 461. 50 | 48. 8 | 13, 433. 10 | 6, 213. 00 | 1. 0 | | | | 2, 066. 00 | 1, 030. 00 | . 2 |
| Wisconsin | 1, 138, 626. 97 | 406, 730. 53 | 136. 7 | 442, 572. 74 | 167, 416. 84 | 70. 5 | 2, 089, 147. 16 | 820, 339. 75 | 259. 8 | 52, 031. 21 | 22, 000. 00 | 2. 7 |
| Wyoming | 337, 544. 09 | 162, 934. 56 | 103. 5 | 1, 049, 559. 22 | 486, 592. 20 | 124. 4 | 615, 742. 34 | 289, 661. 90 | 80. 7 | | | |
| Total | 20, 136, 595. 52 | 8, 380, 620. 47 | 2, 195. 6 | 12, 121, 566. 26 | 5, 553, 687. 31 | 1, 638. 5 | 47, 205, 470. 02 | 21, 005, 497. 08 | 5, 044. 4 | 4, 979, 130. 29 | 2, 162, 143. 99 | 357. 9 |

TABLE 6.—*Summary by types of projects completed and final payments made*—Continued.

| State. | Bituminous macadam. | | | Bituminous concrete. | | | Concrete. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | | | | $1,069,198.21 | $473,511.37 | 23.6 | | | |
| Arizona | | | | 70,332.39 | 24,205.97 | 1.1 | $1,550,207.30 | $792,120.37 | 52.1 |
| Arkansas | $23,282.02 | $10,000.00 | 3.0 | 3,179,511.29 | 905,392.12 | 149.1 | | | |
| California | | | | 370,508.77 | 176,468.16 | 21.4 | 1,791,517.45 | 831,209.26 | 74.1 |
| Colorado | | | | | | | 1,737,096.62 | 829,220.34 | 46.9 |
| Connecticut | 221,821.56 | 110,910.78 | 7.8 | | | | 125,660.79 | 53,000.00 | 5.3 |
| Delaware | | | | | | | 914,294.07 | 360,604.83 | 21.9 |
| Florida | | | | | | | | | |
| Georgia | 1,489,757.27 | 629,206.13 | 48.9 | 86,012.82 | 15,900.00 | 2.5 | 2,485,778.82 | 1,157,794.06 | 74.9 |
| Idaho | | | | 1,066,702.49 | 479,215.20 | 24.6 | 301,537.77 | 140,000.00 | 7.0 |
| Illinois | 127,046.70 | 59,215.31 | 3.3 | 321,429.08 | 156,966.76 | 8.1 | 19,070,012.30 | 9,277,906.55 | 545.8 |
| Indiana | | | | 495,706.70 | 243,050.79 | 12.0 | 2,983,461.47 | 1,429,000.35 | 79.7 |
| Iowa | | | | | | | 5,425,386.49 | 2,258,153.35 | 116.7 |
| Kansas | | | | | | | 3,106,624.88 | 1,034,765.00 | 69.0 |
| Kentucky | 426,200.80 | 149,494.39 | 10.1 | | | | 665,406.01 | 318,588.01 | 17.3 |
| Louisiana | | | | 157,620.29 | 73,740.97 | 5.7 | | | |
| Maine | 845,767.47 | 422,855.29 | 32.4 | | | | 564,180.74 | 242,266.16 | 11.8 |
| Maryland | 416,587.23 | 203,279.91 | 27.3 | 172,021.15 | 86,010.57 | 5.8 | 3,791,181.10 | 1,772,960.46 | 107.2 |
| Massachusetts | 2,142,509.16 | 888,669.08 | 55.4 | 347,974.59 | 154,946.23 | 16.9 | 1,824,634.96 | 693,411.99 | 37.7 |
| Michigan | | | | 198,404.11 | 97,121.95 | 6.3 | 2,218,576.03 | 1,078,198.47 | 73.8 |
| Minnesota | | | | 951,622.53 | 260,099.68 | 22.1 | 1,905,606.27 | 800,341.34 | 59.2 |
| Mississippi | | | | | | | 100,817.57 | 50,272.36 | 2.6 |
| Missouri | 116,394.84 | 58,056.06 | 5.2 | 78,396.94 | 29,176.59 | 2.8 | 1,630,570.17 | 713,926.67 | 47.8 |
| Montana | 59,069.78 | 27,380.00 | 1.4 | | | | 1,070,201.06 | 506,301.24 | 25.9 |
| Nebraska | | | | | | | 272,759.48 | 123,696.12 | 7.4 |
| Nevada | | | | | | | 999,864.00 | 433,053.62 | 22.2 |
| New Hampshire | 348,338.21 | 168,995.77 | 15.4 | 365,184.41 | 171,671.62 | 20.3 | | | |
| New Jersey | 65,049.19 | 30,929.03 | 1.3 | 112,844.70 | 23,240.00 | 2.6 | 2,871,714.02 | 1,102,466.28 | 63.4 |
| New Mexico | | | | | | | 596,731.70 | 298,360.09 | 21.3 |
| New York | 366,726.34 | 172,350.95 | 14.8 | | | | 3,357,302.92 | 1,513,864.96 | 96.0 |
| North Carolina | 379,283.29 | 183,736.94 | 10.6 | 1,612,587.97 | 767,949.35 | 40.7 | 896,603.46 | 378,649.78 | 26.0 |
| North Dakota | | | | | | | 64,903.44 | 18,894.00 | .9 |
| Ohio | 2,678,712.31 | 1,070,817.97 | 98.9 | 1,968,936.08 | 649,624.01 | 52.7 | 5,738,239.66 | 1,907,312.08 | 161.0 |
| Oklahoma | 12,701.60 | 5,850.00 | .6 | 795,689.49 | 370,387.85 | 25.8 | 356,641.76 | 133,238.18 | 7.9 |
| Oregon | | | | 876,839.01 | 437,357.01 | 35.0 | 1,745,396.63 | 686,591.40 | 33.5 |
| Pennsylvania | 221,641.81 | 107,593.11 | 7.5 | 2,382,983.56 | 962,423.73 | 56.8 | 17,776,195.88 | 6,863,130.63 | 353.1 |
| Rhode Island | 358,833.02 | 155,735.28 | 8.7 | 813,502.76 | 348,545.12 | 21.0 | 112,119.11 | 45,800.00 | 2.3 |
| South Carolina | 50,033.78 | 25,016.89 | 3.0 | 245,106.64 | 109,706.96 | 8.3 | 850,166.16 | 383,555.72 | 25.1 |
| South Dakota | | | | | | | | | |
| Tennessee | 655,094.45 | 296,926.53 | 18.5 | 281,755.15 | 137,829.57 | 7.4 | | | |

TABLE 6.—*Summary by types of projects completed and final payments made*—Continued.

| State. | Bituminous macadam. | | | Bituminous concrete. | | | Concrete. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Texas | $193,704.87 | $96,653.06 | 16.9 | $321,020.75 | $159,866.60 | 8.9 | $2,567,847.52 | $996,121.28 | 64.4 |
| Utah | | | | 324,189.20 | 158,895.01 | 7.7 | 124,828.19 | 60,914.09 | 4.0 |
| Vermont | 215,029.60 | 107,102.98 | 7.6 | | | | 86,603.77 | 43,301.88 | 3.4 |
| Virginia | 432,882.24 | 209,794.94 | 16.9 | | | | 1,088,739.14 | 529,986.53 | 36.4 |
| Washington | | | | | | | 4,253,921.79 | 1,973,383.12 | 120.9 |
| West Virginia | 529,769.07 | 248,442.90 | 33.2 | 213,837.57 | 97,526.48 | 11.4 | 876,684.58 | 396,094.15 | 29.6 |
| Wisconsin | 219,250.76 | 103,269.30 | 7.5 | | | | 6,555,023.93 | 2,338,281.71 | 200.5 |
| Wyoming | | | | 177,650.66 | 74,128.03 | 1.2 | 178,391.85 | 81,280.00 | 6.3 |
| Total | 12,595,487.37 | 5,542,282.60 | 456.2 | 19,057,569.34 | 7,644,957.70 | 601.8 | 104,663,430.86 | 44,648,016.43 | 2,762.0 |

TABLE 6.—*Summary by types of projects completed and final payments made*—Continued.

| State. | Brick. | | | Bridges. | | | Totals, all types. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | | | | $186,071.35 | $86,746.34 | 0.9 | $3,117,022.41 | $1,471,037.95 | 319.6 |
| Arizona | | | | 363,888.17 | 180,765.88 | .8 | 3,516,668.68 | 1,733,789.06 | 175.5 |
| Arkansas | | | | | | | 5,137,991.87 | 1,714,903.00 | 449.1 |
| California | | | | | | | 3,097,188.77 | 1,423,937.46 | 160.9 |
| Colorado | | | | 215,235.63 | 107,306.84 | .6 | 3,469,704.74 | 1,631,345.69 | 220.8 |
| Connecticut | | | | | | | 347,482.35 | 163,910.78 | 13.1 |
| Delaware | $671,467.39 | $33,050.00 | 6.2 | | | | 1,615,761.46 | 393,654.83 | 28.1 |
| Florida | | | | | | | 69,466.31 | 29,700.63 | 15.6 |
| Georgia | 13,585.01 | 6,792.50 | .4 | 2,764,140.68 | 1,235,839.53 | 13.4 | 12,463,462.73 | 5,636,278.70 | 730.8 |
| Idaho | | | | 291,208.48 | 140,326.42 | .7 | 6,398,969.93 | 3,028,399.88 | 404.9 |
| Illinois | 453,350.53 | 220,910.10 | 13.5 | 201,449.62 | 76,023.30 | .3 | 23,424,609.01 | 10,668,902.80 | 702.9 |
| Indiana | | | | 10,667.21 | 4,843.76 | | 3,489,835.38 | 1,676,894.90 | 91.7 |
| Iowa | 1,337,973.60 | 386,881.28 | 21.2 | | | | 9,199,214.57 | 3,511,878.62 | 488.9 |
| Kansas | 2,279,113.95 | 683,451.50 | 46.4 | | | | 5,766,072.36 | 1,892,280.87 | 140.2 |
| Kentucky | 223,102.34 | 73,000.00 | 3.9 | | | | 2,857,106.88 | 1,224,965.71 | 130.3 |
| Louisiana | | | | | | | 3,177,925.69 | 1,386,187.59 | 283.2 |
| Maine | | | | | | | 1,819,125.27 | 857,280.65 | 65.3 |
| Maryland | | | | | | | 4,804,945.57 | 2,272,317.90 | 166.9 |
| Massachusetts | | | | | | | 4,360,494.02 | 1,759,714.95 | 113.4 |
| Michigan | | | | | | | 3,528,217.33 | 1,680,192.96 | 162.0 |
| Minnesota | | | | 48,383.48 | 13,000.00 | .1 | 10,481,855.06 | 4,061,832.60 | 1,144.6 |
| Mississippi | 257,046.93 | 126,142.20 | 6.4 | | | | 3,076,712.82 | 1,453,631.39 | 300.5 |
| Missouri | 152,491.97 | 68,506.26 | 3.5 | 192,653.07 | 96,326.53 | .1 | 3,056,395.55 | 1,370,645.18 | 190.0 |
| Montana | | | | 526,238.06 | 262,918.88 | .9 | 5,298,389.77 | 2,591,706.30 | 461.4 |
| Nebraska | 308,343.72 | 96,277.34 | 7.5 | | | | 1,192,299.15 | 499,522.90 | 168.1 |
| Nevada | | | | 119,072.92 | 59,479.24 | .3 | 1,943,657.72 | 877,660.30 | 115.6 |
| New Hampshire | | | | 51,673.55 | 25,683.48 | .1 | 1,882,698.41 | 906,518.19 | 118.2 |
| New Jersey | | | | | | | 3,073,022.31 | 1,161,457.31 | 70.7 |
| New Mexico | | | | | | | 1,784,607.16 | 890,449.48 | 184.7 |
| New York | | | | | | | 3,724,029.26 | 1,686,215.91 | 110.8 |
| North Carolina | | | | 254,759.12 | 107,877.11 | .4 | 5,731,873.82 | 2,605,098.76 | 402.7 |
| North Dakota | | | | 90,232.05 | 43,754.76 | .7 | 1,363,637.95 | 639,879.22 | 311.7 |
| Ohio | 5,494,319.74 | 1,630,710.00 | 128.8 | | | | 16,845,532.51 | 5,653,904.56 | 481.1 |
| Oklahoma | 8,832.00 | 4,050.00 | .4 | 367,996.21 | 182,927.75 | 1.0 | 2,398,173.00 | 1,117,967.15 | 86.2 |
| Oregon | | | | 359,807.27 | 169,741.33 | .3 | 9,036,285.21 | 4,032,957.06 | 449.7 |
| Pennsylvania | 1,001,904.89 | 439,019.76 | 22.7 | | | | 21,382,726.14 | 8,372,167.23 | 440.1 |
| Rhode Island | | | | | | | 1,284,454.89 | 550,080.40 | 32.0 |
| South Carolina | 490.00 | 245.00 | .2 | 259,470.71 | 125,614.55 | .7 | 3,957,404.32 | 1,853,012.58 | 393.6 |
| South Dakota | | | | 96,069.42 | 46,918.16 | .2 | 1,422,406.84 | 699,618.84 | 154.8 |
| Tennessee | | | | 37,349.89 | 18,674.94 | | 1,241,632.29 | 586,897.44 | 41.1 |
| Texas | 134,869.62 | 30,000.00 | 1.6 | 550,238.27 | 247,513.77 | 2.1 | 11,584,549.85 | 4,727,939.21 | 1,130.6 |
| Utah | | | | 16,501.68 | 8,250.84 | | 548,904.15 | 266,499.90 | 21.4 |

TABLE 6.—*Summary by types of projects completed and final payments made*—Continued.

| State. | Brick. | | | Bridges. | | | Totals, all types. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Vermont | | | | $19,035.19 | $9,517.59 | .1 | $540,503.30 | $263,963.82 | 21.9 |
| Virginia | | | | 45,816.81 | 22,213.83 | .3 | 2,693,380.19 | 1,303,618.26 | 174.4 |
| Washington | | | | 205,136.86 | 101,974.53 | .8 | 8,025,743.67 | 3,783,259.11 | 353.8 |
| West Virginia | $405,819.10 | $148,395.75 | 10.3 | | | | 2,687,374.55 | 1,192,163.78 | 134.5 |
| Wisconsin | | | | 26,087.23 | 10,427.07 | .1 | 10,522,740.00 | 3,868,465.20 | 677.8 |
| Wyoming | | | | 101,289.79 | 49,494.07 | .4 | 2,460,177.95 | 1,144,090.76 | 316.5 |
| Total | 12,742,710.79 | 3,947,431.69 | 273.0 | 7,400,472.72 | 3,434,160.50 | 25.3 | 240,902,433.17 | 102,318,797.77 | 13,354.7 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for.*

| State. | Graded and drained. | | | Sand-clay. | | | Gravel. | | | Waterbound macadam. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | | | | $462,811 | $231,406 | 78.7 | $2,822,090 | $1,411,045 | 245.5 | $163,214 | $81,607 | 20.8 |
| Arizona | $229,429 | $120,493 | 25.8 | | | | 2,678,819 | 1,186,930 | 170.4 | | | |
| Arkansas | | | | | | | 2,911,807 | 1,302,548 | 373.1 | 618,636 | 249,750 | 51.6 |
| California | 2,313,979 | 1,176,126 | 143.9 | | | | 3,531,219 | 1,779,406 | 187.6 | | | |
| Colorado | 996,027 | 490,764 | 59.2 | 213,492 | 113,492 | 30.0 | 1,236,369 | 625,364 | 110.9 | | | |
| Connecticut | | | | | | | | | | | | |
| Delaware | | | | | | | | | | | | |
| Florida | 177,059 | 88,530 | 19.2 | 212,927 | 106,464 | 18.5 | 265,457 | 132,729 | 10.0 | | | |
| Georgia | 191,480 | 95,701 | 22.6 | 2,212,986 | 1,046,521 | 340.5 | 520,422 | 252,505 | 57.6 | 389,622 | 194,811 | 20.3 |
| Idaho | 108,374 | 54,187 | 3.0 | | | | 355,383 | 160,283 | 26.6 | | | |
| Illinois | 132,881 | 33,738 | 3.0 | | | | | | | | | |
| Indiana | 840,762 | 420,381 | 18.1 | | | | | | | 252,473 | 126,236 | 7.9 |
| Iowa | 5,244,697 | 2,242,509 | 789.1 | | | | 1,217,544 | 598,400 | 188.5 | | | |
| Kansas | 1,059,857 | 412,583 | 127.9 | | | | 2,379,198 | 991,197 | 120.1 | 158,287 | 79,143 | 8.0 |
| Kentucky | 2,204,677 | 1,102,338 | 155.3 | | | | 627,919 | 313,959 | 39.1 | 1,106,578 | 553,289 | 35.4 |
| Louisiana | | | | | | | 5,380,584 | 2,412,370 | 395.7 | | | |
| Maine | | | | | | | 632,323 | 316,162 | 31.8 | | | |
| Maryland | | | | | | | 43,402 | 21,701 | 5.0 | | | |
| Massachusetts | | | | | | | | | | | | |
| Michigan | | | | | | | 1,975,332 | 982,252 | 135.7 | 140,522 | 70,261 | 8.1 |
| Minnesota | 2,139,652 | 957,133 | 162.1 | 325,249 | 150,000 | 18.0 | 5,822,091 | 1,950,565 | 726.9 | | | |
| Mississippi | 1,121,126 | 541,964 | 138.6 | | | | 2,970,263 | 1,481,662 | 261.2 | 128,100 | 64,050 | 11.3 |
| Missouri | 954,625 | 477,312 | 84.3 | | | | 2,757,017 | 1,321,340 | 244.7 | 381,850 | 191,425 | 43.9 |
| Montana | 839,067 | 431,718 | 87.8 | 731,976 | 374,390 | 82.7 | 728,526 | 368,509 | 89.3 | | | |
| Nebraska | 7,222,666 | 3,591,407 | 1,287.7 | 552,142 | 262,224 | 64.2 | 561,384 | 280,692 | 103.3 | | | |
| Nevada | 155,572 | 119,340 | 30.7 | | | | 1,137,748 | 687,700 | 100.1 | | | |
| New Hampshire | | | | 21,193 | 10,596 | 1.6 | 242,955 | 118,100 | 15.7 | 19,319 | 9,660 | 1.3 |
| New Jersey | | | | | | | | | | | | |
| New Mexico | 643,643 | 364,534 | 255.1 | | | | 3,206,710 | 1,733,729 | 472.3 | | | |
| New York | | | | | | | | | | | | |
| North Carolina | 308,910 | 153,762 | 46.7 | 3,917,638 | 1,954,857 | 362.2 | 159,386 | 55,000 | 23.2 | 444,348 | 222,174 | 19.0 |
| North Dakota | 3,411,254 | 1,705,642 | 741.5 | | | | 1,172,712 | 586,269 | 158.7 | | | |
| Ohio | 284,000 | 130,000 | 14.7 | | | | 160,000 | 80,000 | 6.5 | 1,336,562 | 568,031 | 49.4 |
| Oklahoma | 205,999 | 102,999 | 27.4 | 4,621 | 2,310 | .4 | 3,640,724 | 1,771,569 | 229.4 | | | |
| Oregon | | | | | | | 127,139 | 63,570 | 12.8 | | | |
| Pennsylvania | | | | | | | | | | | | |
| Rhode Island | | | | | | | | | | | | |
| South Carolina | 26,109 | 13,054 | 5.0 | 1,871,379 | 898,206 | 334.4 | 607,434 | 255,112 | 83.7 | | | |
| South Dakota | 813,764 | 406,882 | 130.1 | | | | 5,894,830 | 2,939,906 | 626.8 | | | |
| Tennessee | | | | | | | 1,308,085 | 650,805 | 87.0 | 3,115,234 | 1,551,664 | 122.5 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for*—Continued.

| State. | Graded and drained. | | | Sand-clay. | | | Gravel. | | | Waterbound macadam. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Texas | $79,705 | $17,500 | 14.1 | $32,379 | $14,617 | 14.5 | $16,352,294 | $5,870,815 | 1,426.7 | $7,362,652 | $2,589,610 | 350.9 |
| Utah | 1,049,017 | 524,509 | 136.7 | | | | 912,240 | 456,120 | 79.5 | | | |
| Vermont | | | | | | | 940,657 | 470,328 | 35.7 | 228,874 | 114,437 | 7.1 |
| Virginia | 55,156 | 27,578 | 8.3 | 529,963 | 264,981 | 63.6 | 528,234 | 264,118 | 55.2 | 1,475,099 | 737,550 | 84.3 |
| Washington | 145,729 | 59,100 | 2.2 | | | | 202,723 | 34,736 | 4.9 | | | |
| West Virginia | 1,260,171 | 610,013 | 73.1 | | | | 219,491 | 109,288 | 18.2 | 61,437 | 30,718 | 4.3 |
| Wisconsin | 1,189,131 | 518,046 | 129.2 | 541,945 | 239,409 | 55.7 | 2,501,121 | 1,054,614 | 238.2 | 25,607 | 10,000 | 7.6 |
| Wyoming | 3,152,388 | 1,689,155 | 313.2 | 99,262 | 49,631 | 8.9 | 217,385 | 121,977 | 17.3 | | | |
| Total | 38,556,906 | 18,678,998 | 5,055.6 | 11,729,963 | 5,719,104 | 1,473.9 | 78,979,017 | 35,213,375 | 7,214.9 | 17,408,414 | 7,444,416 | 853.7 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for*—Continued.

| State. | Bituminous macadam. | | | Bituminous concrete. | | | Concrete. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | $1,900,397 | $950,198 | 76.4 | | | | $165,444 | $82,722 | 4.6 |
| Arizona | | | | $82,169 | $50,213 | 2.9 | 586,414 | 358,373 | 18.4 |
| Arkansas | 1,419,804 | 631,101 | 74.9 | 412,984 | 194,300 | 16.7 | 575,364 | 227,800 | 17.4 |
| California | 1,206,584 | 603,292 | 55.0 | | | | 5,200,118 | 2,580,135 | 184.0 |
| Colorado | | | | | | | 1,639,503 | 847,737 | 41.4 |
| Connecticut | 684,530 | 317,313 | 19.2 | | | | 2,205,168 | 822,825 | 41.3 |
| Delaware | | | | | | | 857,975 | 342,000 | 24.9 |
| Florida | 1,958,091 | 979,045 | 63.4 | | | | 464,239 | 218,391 | 18.4 |
| Georgia | 234,569 | 117,285 | 6.6 | | | | 91,844 | 42,987 | 2.9 |
| Idaho | | | | | | | 530,306 | 199,334 | 14.6 |
| Illinois | | | | | | | 1,385,849 | 601,821 | 30.7 |
| Indiana | | | | | | | 7,410,196 | 3,584,871 | 172.3 |
| Iowa | | | | | | | 5,496,601 | 2,369,923 | 150.8 |
| Kansas | 1,907,555 | 684,039 | 49.9 | | | | 11,586,129 | 3,251,448 | 212.9 |
| Kentucky | 2,447,493 | 1,149,786 | 56.5 | | | | 586,014 | 293,007 | 15.9 |
| Louisiana | | | | | | | | | |
| Maine | 2,129,259 | 1,053,400 | 58.1 | | | | 898,504 | 385,421 | 19.8 |
| Maryland | | | | 117,979 | 58,989 | 5.0 | 343,779 | 171,503 | 10.8 |
| Massachusetts | 1,761,508 | 723,129 | 33.2 | 348,802 | 174,401 | 15.5 | 1,792,779 | 665,129 | 31.8 |
| Michigan | | | | 2,004,345 | 891,625 | 44.7 | 7,459,545 | 3,558,362 | 213.2 |
| Minnesota | | | | 177,239 | 51,000 | 2.5 | 3,900,213 | 1,752,043 | 127.0 |
| Mississippi | 174,691 | 79,929 | 5.3 | | | | 1,691,409 | 845,704 | 45.3 |
| Missouri | 1,695,575 | 784,435 | 72.4 | | | | 4,426,803 | 1,848,371 | 109.1 |
| Montana | 254,904 | 127,452 | 6.5 | | | | 77,153 | 15,535 | .5 |
| Nebraska | | | | | | | 94,104 | 35,860 | 1.8 |
| Nevada | | | | | | | 388,930 | 185,200 | 9.3 |
| New Hampshire | 170,230 | 85,115 | 6.6 | 74,185 | 37,093 | 2.2 | | | |
| New Jersey | | | | 157,402 | 47,680 | 2.4 | 3,105,005 | 1,046,566 | 52.4 |
| New Mexico | | | | | | | 270,420 | 166,329 | 13.5 |
| New York | 8,235,458 | 3,161,734 | 210.7 | | | | 9,765,010 | 3,967,993 | 225.8 |
| North Carolina | 918,444 | 418,281 | 31.8 | 870,928 | 332,386 | 30.6 | 386,694 | 143,268 | 8.9 |
| North Dakota | | | | | | | 61,198 | 20,100 | 1.0 |
| Ohio | 829,252 | 256,700 | 22.2 | 748,800 | 286,600 | 20.0 | 2,054,200 | 587,850 | 49.6 |
| Oklahoma | | | | | | | 4,922,145 | 1,768,081 | 126.7 |
| Oregon | | | | 145,210 | 72,605 | 5.5 | 731,206 | 419,424 | 24.1 |
| Pennsylvania | | | | 1,700,762 | 731,740 | 35.3 | 14,287,920 | 4,697,603 | 233.3 |
| Rhode Island | | | | 280,815 | 87,331 | 6.6 | | | |
| South Carolina | | | | 149,926 | 74,882 | 5.9 | 357,719 | 159,111 | 22.0 |
| South Dakota | | | | | | | | | |
| Tennessee | 6,672,909 | 3,336,454 | 214.3 | | | | 1,191,899 | 566,565 | 29.6 |
| Texas | 1,518,291 | 502,467 | 49.9 | 932,684 | 365,000 | 35.6 | [illegible],971,506 | 1,065,872 | 87.1 |
| Utah | | | | | | | 2,112,040 | 1,244,005 | 52.9 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for*—Continued.

| State. | Bituminous macadam. | | | Bituminous concrete. | | | Concrete. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Vermont | | | | | | | $48,131 | $23,571 | .9 |
| Virginia | $1,722,372 | $851,979 | 65.2 | $634,462 | $317,231 | 20.0 | 2,312,133 | 1,131,015 | 67.1 |
| Washington | | | | | | | 756,977 | 356,914 | 18.6 |
| West Virginia | 1,445,108 | 687,351 | 46.0 | | | | 1,999,597 | 724,628 | 49.1 |
| Wisconsin | 146,887 | 65,000 | 5.0 | | | | 1,573,589 | 499,272 | 48.7 |
| Wyoming | | | | | | | 604,267 | 220,787 | 12.1 |
| Total | 39,433,911 | 17,565,485 | 1,229.1 | 8,838,692 | 3,773,076 | 251.4 | 110,266,039 | 44,095,456 | 2,642.5 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for*—Continued.

| State. | Brick. | | | Bridges. | | | Total, all types. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Alabama | | | | $515,086 | $257,543 | 1.2 | $6,029,042 | $3,014,521 | 427.2 |
| Arizona | | | | | | | 3,576,831 | 1,716,009 | 217.5 |
| Arkansas | | | | 377,221 | 100,000 | .6 | 6,315,816 | 2,705,499 | 534.3 |
| California | | | | 736,540 | 368,270 | 1.0 | 12,988,440 | 6,507,229 | 571.5 |
| Colorado | | | | 289,321 | 162,367 | 1.0 | 4,374,712 | 2,239,724 | 242.5 |
| Connecticut | | | | | | | 2,889,698 | 1,140,138 | 60.5 |
| Delaware | | | | | | | 857,975 | 342,000 | 24.9 |
| Florida | $1,931,394 | $875,563 | 44.3 | 883,467 | 441,733 | 2.1 | 5,892,634 | 2,842,455 | 175.9 |
| Georgia | | | | 613,980 | 232,750 | 1.7 | 4,254,903 | 1,982,560 | 452.2 |
| Idaho | | | | 42,073 | 21,036 | .1 | 1,036,136 | 434,840 | 44.3 |
| Illinois | 265,381 | 121,091 | 6.1 | | | | 1,784,111 | 756,650 | 39.8 |
| Indiana | | | | 20,912 | 10,456 | | 8,524,343 | 4,141,944 | 198.3 |
| Iowa | | | | | | | 11,988,842 | 5,210,832 | 1,128.4 |
| Kansas | 3,019,120 | 710,028 | 47.1 | | | | 20,110,146 | 6,128,438 | 565.9 |
| Kentucky | | | | 146,306 | 73,153 | .1 | 7,118,987 | 3,185,532 | 302.3 |
| Louisiana | | | | | | | 5,380,584 | 2,412,370 | 395.7 |
| Maine | | | | 464,348 | 223,950 | .2 | 4,124,434 | 1,978,933 | 109.9 |
| Maryland | | | | | | | 505,160 | 252,193 | 20.8 |
| Massachusetts | | | | 28,264 | 14,132 | | 3,931,353 | 1,576,791 | 80.5 |
| Michigan | | | | | | | 11,579,744 | 5,502,500 | 401.7 |
| Minnesota | | | | | | | 12,364,444 | 4,860,741 | 1,036.5 |
| Mississippi | | | | | | | 6,085,589 | 3,013,309 | 461.7 |
| Missouri | | | | 93,890 | 46,906 | .5 | 10,309,760 | 4,669,789 | 554.9 |
| Montana | | | | | | | 2,631,626 | 1,317,604 | 266.8 |
| Nebraska | | | | 175,522 | 87,761 | .5 | 8,605,818 | 4,257,944 | 1,457.5 |
| Nevada | | | | | | | 1,682,250 | 992,240 | 140.1 |
| New Hampshire | | | | | | | 527,882 | 260,564 | 27.4 |
| New Jersey | | | | | | | 3,262,407 | 1,091,246 | 54.8 |
| New Mexico | | | | 256,496 | 128,248 | 1.4 | 4,377,269 | 2,392,840 | 742.3 |
| New York | | | | 37,956 | 18,978 | .1 | 18,038,424 | 7,148,705 | 436.6 |
| North Carolina | | | | 499,690 | 249,845 | 1.0 | 7,506,038 | 3,529,573 | 523.4 |
| North Dakota | | | | 1,323,996 | 661,998 | .5 | 5,969,160 | 2,974,009 | 901.7 |
| Ohio | 1,760,494 | 497,320 | 30.3 | 106,000 | 53,000 | .1 | 7,279,308 | 2,459,501 | 192.8 |
| Oklahoma | | | | 1,624,871 | 770,774 | 3.2 | 10,398,360 | 4,415,733 | 387.1 |
| Oregon | | | | | | | 1,003,555 | 555,599 | 42.4 |
| Pennsylvania | | | | | | | 15,988,682 | 5,429,343 | 268.6 |
| Rhode Island | | | | | | | 280,815 | 87,331 | 6.6 |
| South Carolina | | | | 1,218,542 | 609,270 | 5.3 | 4,231,109 | 2,009,635 | 456.3 |
| South Dakota | | | | 163,586 | 44,293 | .3 | 6,872,180 | 3,391,081 | 757.2 |
| Tennessee | | | | 69,041 | 34,521 | .4 | 12,357,168 | 6,140,009 | 453.8 |
| Texas | | | | 238,854 | 88,500 | .7 | 30,388,365 | 10,514,381 | 1,979.5 |
| Utah | | | | 38,087 | 19,043 | .6 | 4,111,384 | 2,213,677 | 269.7 |
| Vermont | | | | 14,594 | 7,297 | | 1,232,256 | 615,633 | 43.7 |

TABLE 7.—*Summary by types of projects under construction, including those projects completed but not completely paid for*—Continued.

| State. | Brick. | | | Bridges. | | | Total, all types. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. | Total cost. | Federal aid. | Miles. |
| Virginia | | | | $138,410 | $66,079 | .2 | $7,395,829 | $3,660,531 | 363.9 |
| Washington | | | | 63,156 | 25,000 | .2 | 1,168,585 | 475,750 | 25.9 |
| West Virginia | $24,852 | $10,500 | 1.0 | 75,358 | 37,679 | .3 | 5,086,014 | 2,210,177 | 192.0 |
| Wisconsin | | | | | | | 5,978,280 | 2,386,341 | 484.4 |
| Wyoming | | | | 364,154 | 191,171 | 1.8 | 4,437,456 | 2,272,721 | 353.3 |
| Total | 7,001,241 | 2,214,502 | 128.8 | 10,619,721 | 5,045,753 | 25.1 | 322,833,904 | 139,750,165 | 18,875.0 |

## NATIONAL FOREST ROADS.

The appropriation made by the Federal highway act for forest roads is divided into two specific funds—(1) for the survey, construction, reconstruction, and maintenance of roads and trails of primary importance for the protection, administration, and utilization of the national forests or when necessary for the use and development of the resources upon which such communities within or adjacent to the national forests are dependent; and (2) for the survey, construction, reconstruction, and maintenance of forest roads of primary importance to the State or communities within, adjoining, or adjacent to the national forests. Administratively the two funds are known as the forest-development fund and the forest-highway fund.

Projects to be constructed from the second part of the appropriation are selected so as to coincide or correlate with the Federal-aid highway system. It is the policy of the bureau to use the funds under this part of the appropriation, so far as possible, to complete and make continuous the important State routes through the forest areas. On account of the large areas of forest lands within the boundaries of some of the Western States it is necessary, in order to obtain a complete and connected system of highways that will serve the State and the local communities, to combine the Federal-aid highways and these forest highways into one system. The rules and regulations for the administration of national forest roads and trails have definitely provided a line of procedure to be followed in the selection and the construction of these projects.

Each of the State highway departments will submit, through the proper district engineer, a map of the State showing the forest areas within the State, the Federal-aid highway system, and the highways recommended by the highway department for construction as national forest highways. Before submitting its map the highway department will secure and consider the recommendations of county officials as to forest highways of importance to the counties. Having worked out a map which will embody the State and county recommendations as decided upon, the map will be transmitted to the proper district engineer of the bureau, who will attach his recommendations and forward them with a copy of the State map to the district forester. The district forester will prepare another map showing the existing roads in and adjacent to the forest areas, indicating the roads proposed for improvement and which of them should be improved, in his judgment, as parts of the forest highway system and forest development road system, respectively.

Upon the basis of the several recommendations a joint recommendation will be prepared in conference between representatives of the State highway department, the district engineer of the bureau, and the district forester. Following this conference final recommendations for the designation of the forest highway system will be submitted to the Secretary by the Chief of the Bureau of Public Roads and the Forester, and such recommendations will be embodied in a map. This map, when approved, will constitute the general program for highway construction in the forest areas. It will undoubtedly take some time and very careful study before these maps can be finally adopted. In the meantime a program for construction and surveys for the 1922 and 1923 seasons has been set up by agreement between the Forester and the Chief of the Bureau of Public roads, and an earnest attempt has been made, in the selection of projects for this program, to incorporate only such projects as will eventually be a part of the general combined system of Federal-aid highways.

In addition to the projects under the appropriation carried by the Federal highway act, a considerable amount of construction authorized under former appropriations by Congress has been carried on. The status of all of the forest highway projects is shown in the tabulations.

For the administration of national forest road work a regional office was established at San Francisco during the preceding fiscal year, and the highway work in the five western districts is handled through this office under the direction and supervision of a deputy chief engineer. The work in the eastern districts is being handled through the various district engineers and the Washington office. The amount of forest road work in the eastern districts is comparatively small, and this arrangement seems to be working out very satisfactorily.

TABLE 8.—*Forest road projects under construction.*

| District and State. | Number of projects. | Miles. | Construction disbursements to date. | Indicated final cost. | Per cent completed. |
|---|---|---|---|---|---|
| District No. 1: | | | | | |
| Alaska | 7 | 26.80 | $184,410.88 | $517,467.89 | 36 |
| Montana | 1 | 12.23 | 20,699.42 | 108,948.80 | 20 |
| Oregon | 17 | 99.65 | 253,559.64 | 1,920,639.16 | 11 |
| Washington | 4 | 27.05 | 70,954.71 | 380,909.91 | 17 |
| District No. 2: California | 3 | 13.80 | 40,573.95 | 479,094.92 | 7 |
| District No. 3: | | | | | |
| Colorado | 5 | 93.11 | 584,680.27 | 1,107,522.15 | 53 |
| South Dakota | 2 | 11.58 | 19,955.60 | 101,647.57 | 16 |
| Wyoming | 3 | 98.27 | 457,050.30 | 690,537.20 | 80 |
| District No. 6: Arkansas | 1 | 9.66 | 70,000.00 | 105,000.00 | 67 |
| District No. 10: Virginia | 1 | 6.70 | 51,153.60 | 91,362.15 | 62 |
| District No. 12: | | | | | |
| Idaho | 5 | 51.09 | 134,908.10 | 360,865.07 | 35 |
| Utah | 3 | 19.40 | 155,786.40 | 157,786.40 | 90 |
| Wyoming | 1 | 46.40 | 107,138.55 | 170,916.04 | 63 |
| District No. 13: | | | | | |
| Arizona | 1 | 44.31 | 21,136.37 | 215,179.94 | 9 |
| New Mexico | 3 | 18.11 | 52,491.33 | 134,250.38 | 32 |
| Total | 57 | 578.16 | 2,224,499.12 | 6,542,127.58 | 30 |

TABLE 9.—*Forest road projects completed.*

| District and State. | Fiscal year 1917. | | | Fiscal year 1918. | | |
|---|---|---|---|---|---|---|
| | Project. | Miles. | Total cost. | Project. | Miles. | Total cost. |
| District No. 1: | | | | | | |
| Alaska | | | | | | |
| Idaho | | | | | | |
| Montana | | | | | | |
| Oregon | | | | 1 | 2.65 | $9,142.00 |
| Washington | | | | | | |
| District No. 2: California | 1 | 3.80 | $159.33 | 1 | 14.60 | 27,126.70 |
| District No. 3: Colorado | | | | | | |
| District No. 4: Minnesota | | | | | | |
| District No. 8: Florida | | | | 1 | | 32.00 |
| District No. 12: | | | | | | |
| Idaho | | | | | | |
| Utah | | | | | | |
| Wyoming | | | | | | |
| District No. 13: New Mexico | | | | | | |
| Total | 1 | 3.80 | 159.33 | 3 | 17.25 | 36,300.70 |

TABLE 9.—*Forest road projects completed*—Continued.

| District and State. | Fiscal year 1919. | | | Fiscal year 1920. | | |
|---|---|---|---|---|---|---|
| | Project. | Miles. | Total cost. | Project. | Miles. | Total cost. |
| District No. 1: | | | | | | |
| Alaska | | | | 1 | 3.75 | $32,609.44 |
| Idaho | | | | 1 | 3.00 | 26,409.67 |
| Montana | 1 | 4.10 | $72,038.95 | 4 | 36.93 | 205,010.75 |
| Oregon | | | | 4 | 25.88 | 420,069.07 |
| Washington | | | | 6 | 19.06 | 383,622.26 |
| District No. 2: California | 1 | .90 | 19,929.70 | 5 | 12.51 | 255,710.98 |
| District No. 3: Colorado | | | | 3 | 25.75 | 169,913.28 |
| District No. 4: Minnesota | 1 | .10 | 19,999.82 | | | |
| District No. 8: Florida | | | | 2 | 28.33 | 95,692.57 |
| District No. 12: | | | | | | |
| Idaho | | | | 1 | 19.90 | 183,611.90 |
| Utah | 1 | 10.50 | 26,699.23 | | | |
| Wyoming | | | | 1 | 11.00 | 33,116.13 |
| District No. 13: New Mexico | | | | 2 | 19.01 | 87,945.34 |
| Total | 4 | 15.60 | 138,667.70 | 30 | 205.12 | 1,893,711.39 |

TABLE 9.—*Forest road projects completed*—Continued.

| District and State. | Fiscal year 1921. | | | Fiscal year 1922. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Projects. | Miles. | Total cost. | Projects. | Miles. | Total cost. | Projects. | Miles. | Total cost. |
| District No. 1: | | | | | | | | | |
| Alaska | 2 | 7.00 | $89,952.85 | 4 | 37.45 | $201,460.39 | 7 | 48.20 | $324,022.68 |
| Idaho | 3 | 46.37 | 588,655.83 | 1 | 9.69 | 148,910.35 | 5 | 59.06 | 763,975.85 |
| Montana | 9 | 76.72 | 440,091.98 | 9 | 40.84 | 361,013.93 | 23 | 158.59 | 1,078,155.61 |
| Oregon | 9 | 61.57 | 678,650.82 | 17 | 69.21 | 1,235,380.64 | 31 | 159.31 | 2,343,242.53 |
| Washington | 3 | 26.80 | 565,595.61 | 7 | 32.79 | 632,055.30 | 16 | 78.65 | 1,581,273.17 |
| District No. 2: | | | | | | | | | |
| California | 6 | 33.98 | 775,622.19 | 4 | 22.11 | 475,115.16 | 18 | 87.90 | 1,553,664.06 |
| Nevada | 2 | 25.90 | 117,957.74 | | | | 2 | 25.90 | 117,957.74 |
| District No. 3: | | | | | | | | | |
| Colorado | 3 | 30.82 | 95,947.78 | 2 | 36.83 | 330,144.16 | 8 | 93.40 | 596,005.22 |
| South Dakota | 1 | 15.13 | 95,624.22 | 1 | 6.77 | 55,701.39 | 2 | 21.90 | 151,325.61 |
| Wyoming | | | | 2 | 7.30 | 55,388.64 | 2 | 7.30 | 55,388.64 |
| District No. 4: Minnesota | | | | 1 | 15.04 | 154,943.52 | 2 | 15.14 | 174,943.34 |
| District No. 6: Arkansas | 1 | 33.85 | 87,654.65 | | | | 1 | 33.85 | 87,654.65 |
| District No. 8: | | | | | | | | | |
| Florida | | | | 1 | .29 | 11,826.38 | 4 | 28.62 | 107,550.95 |
| Tennessee | | | | 1 | 12.23 | 160,584.63 | 1 | 12.23 | 160,584.63 |
| District No. 10: North Carolina | 1 | 10.10 | 123,326.44 | 1 | 20.90 | 213,676.00 | 2 | 31.00 | 337,002.44 |
| District No. 12: | | | | | | | | | |
| Idaho | 5 | 79.23 | 308,988.31 | 3 | 12.50 | 102,811.30 | 9 | 111.63 | 595,411.51 |
| Utah | 8 | 152.27 | 691,194.74 | | | | 9 | 162.77 | 717,893.97 |
| Wyoming | | | | | | | 1 | 11.00 | 33,116.13 |
| District No. 13: | | | | | | | | | |
| Arizona | 5 | 51.03 | 523,730.20 | 1 | 37.72 | 116,345.18 | 6 | 88.75 | 640,075.38 |
| New Mexico | 4 | 77.92 | 486,714.71 | 1 | 7.22 | 38,252.50 | 7 | 104.15 | 612,912.55 |
| Total | 62 | 728.69 | 5,669,708.07 | 56 | 368.89 | 4,293,609.47 | 156 | 1,339.35 | 12,032,156.66 |

## DISTRIBUTION OF SURPLUS WAR MATERIALS, EQUIPMENT, AND SUPPLIES.

One of the most helpful services rendered to the States has been the distribution of road-building machinery, equipment, and supplies from the surplus war material of the Army. The material, thus distributed, has enabled many of the States to organize and equip maintenance divisions to patrol the entire State road system. Approximately $190,000,000 worth of property, including 30,000 motor vehicles, has been distributed.

The largest item of these surplus materials delivered during the past year is made up of shop machinery and shop tools and equipment, the distribution of which has enabled the several State highway departments to equip shops in which motor vehicles and other motor-driven machinery, also received from the Government, have been reconditioned and repaired. This shop machinery consists in the main of lathes, tool grinders, milling machines, cutting machines, planers, drill presses, and electric motors.

Other major items received from the War Department's surplus include the following, approximately in the quantities noted:

| | | |
|---|---|---|
| 80-pound relaying rail | tons | 25,000 |
| 25-pound industrial rail | do | 10,000 |
| Motor vehicles, including 1,118 Dodge touring cars and light delivery trucks | | 5,000 |
| Picric acid | pounds | 12,500,000 |
| TNT | do | 8,000,000 |
| Sodium nitrate | do | 24,000,000 |
| Ammonium nitrate | do | 5,000,000 |

Of the picric acid received, approximately 8,000,000 pounds have already been distributed. The explosive as received from the War Department is put up in cartridges similar to commercial dynamite and shipped to the States for road-building and land-clearing purposes at 6 cents per pound f. o. b. Fort Wingate, N. Mex., Sparta, Wis., and Edgewood Arsenal, Md.

The nitrates are to be mixed with TNT at Sparta and distributed from there to the States in the form of a modified TNT, which is also to be used for road building. The nitrates received, when mixed with the TNT, will produce 37,000,000 pounds of a very satisfactory explosive.

The department has secured a ruling from the Interstate Commerce Commission permitting the shipment of surplus war materials, except motor trucks, to be made as contractor's equipment, second-hand. This ruling has reduced the freight charges assessed the States to a considerable extent and has encouraged the Western States to make larger requisitions.

In addition to the material distributed from the excess stores at camps and arsenals in the United States, there are now being returned from Germany and France 150 motor trucks, 23 Cadillac automobiles, and 3,000,000 pounds of spare motor vehicle parts, shop machinery, and machine tools.

The following table shows the value of surplus war materials actually received by the State highway departments and the Department of Agriculture up to June 30, 1922:

| State. | Total value of material delivered. | State. | Total value of material delivered. |
|---|---|---|---|
| Alabama | $2,352,057 | New Jersey | $2,128,139 |
| Arizona | 2,436,823 | New Mexico | 2,148,374 |
| Arkansas | 2,376,257 | New York | 7,874,065 |
| California | 4,463,012 | North Carolina | 3,777,655 |
| Colorado | 3,189,530 | North Dakota | 1,621,603 |
| Connecticut | 776,426 | Ohio | 5,372,866 |
| Delaware | 419,263 | Oklahoma | 2,692,467 |
| Florida | 2,126,165 | Oregon | 2,058,265 |
| Georgia | 4,244,778 | Pennsylvania | 4,528,909 |
| Idaho | 1,563,328 | Rhode Island | 336,770 |
| Illinois | 6,314,468 | South Carolina | 1,964,464 |
| Indiana | 5,067,439 | South Dakota | 2,904,169 |
| Iowa | 3,627,527 | Tennessee | 3,938,101 |
| Kansas | 3,819,984 | Texas | 7,855,378 |
| Kentucky | 2,415,469 | Utah | 1,439,278 |
| Louisiana | 2,001,044 | Vermont | 748,818 |
| Maine | 1,129,080 | Virginia | 3,270,993 |
| Maryland | 1,674,163 | Washington | 1,478,738 |
| Massachusetts | 1,286,304 | West Virginia | 3,251,135 |
| Michigan | 6,033,424 | Wisconsin | 3,735,374 |
| Minnesota | 3,384,433 | Wyoming | 1,133,277 |
| Mississippi | 2,994,715 | | |
| Missouri | 4,448,381 | Total | 139,773,986 |
| Montana | 2,291,787 | Retained by Department of Agriculture | 10,473,750 |
| Nebraska | 3,210,623 | | |
| Nevada | 1,314,817 | | |
| New Hampshire | 532,853 | Grand total | 150,147,736 |

## ROAD-MATERIAL TESTS AND RESEARCH.

As previously mentioned, the activity in research and the promising results that have been obtained have been outstanding developments of the past fiscal year. To some extent the bureau has been associated with practically all the major investigations that have been in progress.

The research carried on by the division of tests at the department experimental farm at Arlington, Va., is regarded not only as the most important function of the division, but as one of the most valuable services the bureau is performing.

Road design has until recently been almost entirely a matter of judgment and precedent. Even when the probable weight of the traffic that would follow improvement has been ascertainable, and the climatic and soil conditions have been known with a fair degree of definiteness, the lack of definite knowledge of the effects of these factors upon the road has prevented the employment of such scientific methods of design as have been applied to other engineering structures. The purpose of such investigations as are now being conducted is to develop such methods of road design, and though the results thus far obtained are indicative rather than conclusive, certain fundamental principles are gradually being evolved that ultimately will form the basis of scientific methods and permit the design of more durable and economical roads.

The investigations at Arlington include the measurement of motor-truck impact on highway surfaces, determination of the resistance to impact of various kinds of road surfaces, the drainage of subgrades, the characteristics of subgrade materials, the study of the warping and movement of road surfaces due to natural causes, accelerated tests of various surfacing materials to determine their resistance to the wear of traffic, and bridge investigations, including the distribution of stress in skew arches and the impact stresses set up in bridges by moving loads.

To the State Highway Department of Illinois and the Highway Commission of California, cooperating with the Columbia Steel Co. of Pittsburg, Calif., the country is indebted for two researches, conducted at Bates, Ill., and Pittsburg, Calif., on a scale never before attempted. Both of these investigations had for their purpose the testing of actual road surfaces of various designs under actual traffic. By the boldness with which these tests were conceived and the thoroughness with which they were conducted the two State departments and the steel company have made the outstanding contributions of the year to the advancement of the science of highway engineering.

The researches completed last year at Arlington and those at the Bates road in Illinois and at Pittsburg, Calif., in which the bureau cooperated, have thrown considerable light on the traffic-resisting qualities of road surfaces of different designs laid on various subgrade materials, and have led to certain tentative conclusions as to the proper thickness of slab for different weights of vehicle. Immediate results are apparent in the altered standards of design in some States, and as the information is gradually disseminated other States will no doubt follow. Results of the motor-truck impact tests are being used as the basis for the amendment of laws governing the weight of motor vehicles.

There is still need, however, for much more investigation. Information is badly needed as to the physical characteristics of subgrade materials which are causing certain roads to give short service, the proper manner of draining soils of different types or their possible treatment with admixtures of stabilizing materials, and the relative strength of bituminous surfaces on concrete bases as compared with concrete slab surfaces.

### RESEARCHES CONDUCTED DURING THE YEAR.

In addition to the motor-truck impact and subgrade investigations continued from the previous fiscal year, the following specific researches have been carried forward during the year:

Preparations have been completed for the investigation of relative wear of different concrete surfaces. These surfaces are constructed on a circular track 625 feet in circumference, in which there are 62 sections of different qualities of concrete. These will be subjected to the wear of a rubber-tired truck and the results will be compared with physical laboratory tests.

Another circular track has been surfaced with bituminous mixtures of different qualities. These sections will be subjected to actual motor-truck traffic for the purpose of studying their stability and determining the laws governing the stability of bituminous mixes. This investigation has been instituted with the idea of rendering bituminous roads less likely to wave under traffic.

Special studies have been conducted in the field for the purpose of analyzing the causes of rhythmic corrugations in gravel roads with a view to their prevention. This is a most important subject, in view of the large mileage of gravel roads already built. In connection with this work a laboratory study of gravel is being made.

Investigations of the warping and movement of road slabs as a result of temperature changes, frost, moisture, and other natural causes have been carried on at Arlington.

Two bridge investigations have been instituted, one consisting of the measurement of impact stresses and the other aiming to throw light on the design of skew arches. A special photographic strain gauge has been developed which permits of the very accurate determination of impact stresses.

A field investigation of various types of culvert pipe in the Southern States has been completed.

### RESEARCHES IN CONNECTION WITH NONBITUMINOUS MATERIALS.

The following researches have been conducted in connection with the use and characteristics of nonbituminous materials: A study of the effect of alkali in mixing water on the strength of cement mortar; a method of treating concrete drain tile with water-gas tar has been developed which seems to greatly retard the destruction of this kind of tile by alkalis. Analyses were made of 160 concrete sands for the purpose of determining to what extent the color test for organic content is dependable. An impact test was developed for the purpose of determining the quality of gravel aggregates, and an investigation was carried on in cooperation with the American Society for Testing Materials with the object of standardizing a compression test for rock.

In connection with the accelerated wear test which is to be conducted at Arlington a series of abrasion tests were made on samples of crushed stone, gravel; sand, slag, chats, etc., from various parts of the United States. These aggregates, which have widely varying qualities, are to be used in the construction of the experimental concrete road sections, and by correlating the results of the two series of experiments it is believed that it will be possible to establish a relation between the quality of aggregates and the wear of the pavement.

### RESEARCH IN CONNECTION WITH BITUMINOUS MATERIALS.

Investigational work on bituminous materials has been concentrated upon bituminous mixtures such as are used in the construction of bituminous concrete and sheet-asphalt pavements. A number of projects are under way which will lead to a better knowledge of the essential characteristics of such mixtures and of suitable methods for testing their qualities.

To supplement the special tests of bituminous concrete pavements which will be made at Arlington to determine the cause of wavy surfaces, a study of asphalt pavements has been instituted in five important cities in which different climatic conditions prevail. This study will be conducted in cooperation with the street departments of the cities and the Asphalt Association. It will involve a comprehensive series of tests of a large number of samples taken from typical streets. The testing, which is now well under way, is designed to determine the characteristics of sheet-asphalt mixtures that render them susceptible to the formation of waves.

In addition, a laboratory study of bituminous mixtures is in progress to study methods of testing and determine essential qualities of such mixtures as are used in highway construction.

A number of investigations on oils, asphalts, and tars have been carried out, particularly as to the methods of making the fixed-carbon tests, the results of the volatilization test as applied to road oils by two methods extensively used, and the consistency of refined tars as determined by means of the softening point and float test. The results of these investigations have been used in compiling specifications for suitable bituminous road materials.

A number of investigations looking to the standardization of various tests for the quality of bituminous materials have been made generally in cooperation with the American Society for Testing Materials and the American Association of State Highway Officials. A detailed study of the viscosity test has been undertaken and partially completed, and the method of conducting the float test has been standardized. Further work has been carried out in connection with the distillation test for bituminous road materials. The committee on tests of the American Association of State Highway Officials has held a number of meetings in various sections of the country at which the bureau has been represented, and a great deal of progress has been made in standardizing methods of testing to be applied to materials used in Federal-aid road construction.

### FEDERAL-AID TESTING.

One of the important functions of the division of tests is the testing of materials used in Federal-aid road construction. The routine testing of such materials is performed in a large number of State highway laboratories and commercial laboratories throughout the country. This is necessary in order that the work may be done expeditiously. It is highly important that such testing be performed in a standard manner and with skilled and careful operators. The division of tests, by the use of check samples and by personal visits to the various laboratories, aids in the establishment of standard methods of testing and gives information on the correct methods to be used. During the fiscal year 1,160 samples of materials used in Federal-aid construction were received for testing, and personal visits were made to 37 road-materials laboratories performing tests on Federal-aid materials.

### INVESTIGATIONS IN COOPERATION WITH OTHER AGENCIES.

In connection with its research program, the bureau has established cooperative relations with other institutions, which give it the benefit of increased personnel and testing facilities at a comparatively low cost, and which will reduce the time necessary to complete the work. Under the cooperative arrangements the cooperating agency pays for approximately one-half of the cost of the investigation. During the past year such cooperative investigations have been conducted by Purdue University, Iowa State College, University of Maryland, University of Texas, Kansas Agricultural College, Massachusetts Institute of Technology, North Carolina State Highway Department, and New Hampshire State Highway Department. We have also worked in cooperation with the Illinois and California State highway departments. The investigations conducted involve field investigations of sand-clay roads, investigations of tractive resistance, and laboratory investigations of the properties of road-making materials.

### ROUTINE TESTING OF BITUMINOUS AND NONBITUMINOUS MATERIALS.

In addition to the Federal-aid samples tested, tests were made by the chemical laboratory upon 445 samples of bituminous material, 160 samples of metal, and 42 samples of miscellaneous materials. The nonbituminous testing laboratory examined 1,283 samples of various materials, including rock, sand, gravel, cement, concrete, slag, and brick. In the petrographic laboratory 991 samples were examined, including 431 samples of rock, 262 of gravel, 239 of sand, 19 of clay, 37 of slag, and 3 miscellaneous samples. In addition, the petrographer conducted a special investigation of the microscopic portions of certain subgrade materials, in connection with which a special dye adsorption test was developed for investigating the clay and suspension clay portions.

### ECONOMIC INVESTIGATIONS AND RESEARCH.

Recognizing the necessity of centralizing research in the fields of highway transportation, finance and valuation plans have been made for the organization of a division of highway economics as a separate division of the bureau beginning with the new fiscal year. A certain amount of investigational work has been done along these lines, but for the last three years there has been no special section of the organization charged with the responsibility of that particular kind of work.

This year several very satisfactory studies have been made directly under the office of the chief of bureau, the most prominent of which were two traffic surveys conducted in cooperation with the Connecticut State Highway Department on the Boston Post Road and the road from Hartford, Conn., to Springfield, Mass. The survey on the Boston Post Road was made near Greenwich, Conn., and that on the Hartford-Springfield Road was made near the Massachusetts line. Certain very illuminating data with regard to the weight and number of vehicles, the character of commodities transported by highway, and the length of haul by highway were obtained in those studies.

During the summer of 1921 a survey of highway traffic, finance, and valuation was conducted in cooperation with the University of Tennessee and the highway department of that State in several Tennessee counties.

Both of these surveys, their scope somewhat extended, will be continued during the next fiscal year, and it is expected that the Connecticut survey in particular will produce traffic data records on a scale never before attempted. The survey will include the recording of vehicle traffic and the movement of commodities over the highways of the State for a period of a year, and it is hoped that it will provide much of the highway transport data so fundamental in the solution of modern highway problems.

During the spring of 1922 a survey was made in four Wisconsin counties of the total highway funds raised from all sources of revenue. This analysis, the purpose of which was to yield a better knowledge of the distribution of the burden of highway construction and maintenance costs to various classes within a community, included a comparison of urban and rural contributions to highway improvements. Financial researches are now in progress designed to develop the fundamental principles of sound highway financing.

A survey of the influence of highway improvements on rural land values was also made in four Wisconsin counties in January, February, and March. The relative influence of earth, gravel, and concrete roads was observed by a study of assessment values, checked by true sales.

With the opening of the new year a complete survey of highway transportation, finance, and valuation in California is planned to obtain fundamental data applicable to the Pacific Coast States. A similar survey is to be conducted in a typical agricultural region. In this survey emphasis will rest upon the movement of produce from the farm to the market.

Surveys in transportation, finance, and valuation are also contemplated in a combined industrial-agricultural State and a typical southern State. When the researches in Connecticut, an industrial State, in California, a Pacific coast State, in an agricultural State, a typical industrial-agricultural State and a southern State are completed it is hoped that a sufficient amount of highway transport data and financial and valuation data will be assembled to guide highway policies in States and sections which are comparable to the regions selected.

## EXTENSION ACTIVITIES.

In the 30 years of its history the bureau has contributed conspicuously in many ways to the development of an intelligent public sentiment with regard to road improvement, and since the consolidation by which the agricultural engineering activities of the department were made a part of its duties, it has also carried on a successful extension work with respect to irrigation, land drainage, and matters connected with the structural arrangement and convenience of the farm home.

Though it has been somewhat overshadowed by the immensity of the Federal-aid task, this educational work is still actively carried on.

By means of lectures and addresses before public meetings, conventions, schools, and colleges, by exhibits at State fairs, automobile shows, and the conventions of engineers, by Department and Farmers' Bulletins issued from time to time as need required and information justified, by means of articles in the technical and popular periodicals and daily press, and through the agency of the motion picture, information acquired by the bureau has been made available to the public.

In the loss of its monthly magazine, Public Roads, publication of which was suspended in December after three and a half years of valuable service, the bureau was deprived of its most important educational medium. It had come to be recognized by the engineering profession as one of the more important and useful engineering journals, and the suspension of its publication brought many expressions of regret not only from its engineer subscribers, but also from the nontechnical administrative heads of county highway activities to whom it had been helpful. Not the least gratifying of such expressions were those which came entirely without solicitation from the editors of other technical engineering journals. In view of the many important researches which are being conducted by the bureau with its own forces and in cooperation with other research agencies, and the absolute necessity of a medium by which the results of these investigations can be given to the public, it is hoped that authority to resume publication will be granted as promptly as possible.

In cooperation with the Highway Education Board, on which are represented with the bureau, the United States Bureau of Education, the War Department, the Society for Engineering Education, and various industries interested in the development of an adequate highway system, a great deal of valuable work has been done looking to the stimulation of technical education in highway and highway transport engineering. By direct contact with educators in conferences held at a number of the larger engineering schools, by lending its assistance in devising courses of study, and by supplying material for instruction in the form of stereopticon slides, motion-picture films and models of various types of roads the experience and resources of the bureau have been placed at the disposal of the colleges. Special sets of small models light enough to be cheaply transported from school to school and strong enough to stand repeated handling have been made for this purpose, and new lantern slides descriptive of the latest engineering practice are also being made.

Six motion-picture films, each approximately 1,000 feet in length, were developed during the year in cooperation with the Division of Publications. With the other films previously prepared there are now at the disposal of the department motion pictures depicting the construction of every important type of road, with the exception of the gravel road, and, in addition, three pictures which show the construction of roads in the national forests.

In addition to the exhibits displayed at agricultural fairs under the auspices of the Office of Exhibits, the bureau has also prepared large exhibits for use at the more important highway engineering conventions and other gatherings of persons especially interested in the highways. The more important of these displays were made at the annual convention of the American Association of State Highway Officials at Omaha, Nebr., the meeting of the American Road Builders' Association at Chicago, and the automobile show at New York.

As a contribution to the department's exhibit at the international exposition at Rio de Janeiro, Brazil, the bureau prepared a large model of a gravel road in course of construction with a realistic background supplied by an oil painting. This exhibit is one of the most ambitious that the bureau has attempted, and it has proved to be a most interesting and instructive as well as very beautiful addition to the American display at the Brazilian exposition.

Another contribution to American activity in connection with this exposition was made indirectly through the special highway bulletin of the Pan American Union issued in March. Most of the material in this publication was prepared by the bureau.

Numerous special magazine articles, addresses, and lectures by the personnel of the bureau, and hundreds of short articles of an informative character issued through the press service to the newspapers of the country constitute the less spectacular, but no less valuable educational service which is being rendered by the bureau every day of the year.

## FARM-IRRIGATION INVESTIGATIONS.

Great progress has been made in the art of irrigation during the 60 years which have elapsed since the first crude irrigation works were built. In 1920 the area irrigated in the United States amounted to approximately 19,000,000 acres and the annual gross returns from irrigated lands is now nearly a half billion dollars. In the task of converting so large an extent of arid lands into highly productive fields and orchards this bureau, through its irrigation investigations, has rendered substantial aid.

With large areas being put under irrigation for the first time, frequently by inexperienced irrigators, and the need for conserving water to meet the increased demand the bureau has published several bulletins, based upon its investigations, as an aid to the economical and successful practice of irrigation.

Methods of applying water to land have been studied in the principal irrigated sections and the results published in Farmers' Bulletins. The Border Method of Irrigation, recently issued, describes variations in this important method adapted to different conditions and another bulletin on the corrugation method of irrigation has been prepared for publication.

Wells as a source of irrigation water have been increasingly used in recent years. Frequently this method is the only one available for bringing rich land under cultivation, and it is adapted to the development of small areas. Assistance has been given on a good many projects of this kind, and a bulletin based on observations of the successful practice of this method has been prepared for publication.

In spite of the fact that irrigation has been practiced for many years throughout the West, many mistakes are made in the design of new projects which might be avoided by a study of the experience in the operation of the older ones. To overcome this to a degree, a study has been made by the bureau of irrigation in northern Colorado in cooperation with the Colorado Agricultural Experiment Station. This investigation has covered all phases of irrigation in one of the oldest and most successful irrigated regions, and the results are now available in Department Bulletion No. 1026, Irrigation in Northern Colorado.

A detailed study of drainage structures used in the drainage of irrigated lands has been made, the results of which will be embodied in a report now in preparation. Investigations have also been made of the rise of alkali and the capacities of drainage ditches and tiles.

The irrigation district has been rapidly growing in favor as a form of organization for the reclamation of arid land or for the improvement of existing irrigation systems. The irrigation division has in the past assisted a number of the Western States in perfecting laws relating to such districts, and during the past year a careful study was made of the operation of the irrigation district law in each of the

States in which such districts have been established and a report submitted for publication on "Irrigation District Development in the United States."

Hydraulic experiments have been continued at the Fort Collins (Colo.) laboratory and at the field laboratory near there. Especial attention has been given to evaporation experiments, but these studies have not yet been carried far enough to warrant publication of the results. Several of the new current meters devised by a member of the division have been constructed and sent out for use under field conditions.

The division has continued to render assistance to communities in the organization of irrigation and drainage districts, having for their purpose the reconstruction or improvement of existing systems or the installation of new works of irrigation or drainage. This is considered an important phase of the work, as mistakes made in the initial stages of organization sometimes lead to serious difficulties and even failure of a project.

It is not generally known that the cost of securing a water supply for arid land, including the building of storage reservoirs, diversion dams, canals, and other works necessary to bring the water to the farm, is frequently less than the farmer's expense in preparing his land for irrigation, building the necessary improvements, purchasing equipment, etc. This is one of the rather surprising facts brought out by data which have been collected recently relating to the cost of irrigation water and the cost of establishing an irrigated farm. The study of the cost of irrigation water has thus far been confined to the State of California, but the investigation as to the cost of establishing an irrigated farm has covered the entire West. The results when available will be of assistance to new enterprises and to prospective settlers on irrigated farms.

## FARM-DRAINAGE INVESTIGATIONS.

In the field of agricultural drainage the problems that may be studied with profit are many and varied. A few of these stand out because they affect so directly and obviously the pocketbook of the farmer. It is to this latter class that the bureau must confine itself.

These basic projects, from their very nature, must continue from year to year. Consider, for example, the matter of depth and spacing of tile drains. Shall the farmer of the fine sandy loams of North Carolina space his tile lines 100 feet or 135 feet apart? In this decision is involved a matter of some $10 or $15 per acre drained. Studies made in Pitt County, N. C., during the last two years have shown that the wider spacing is satisfactory. Plainly, however, this determination for the sandy soils of the Coastal Plain of North Carolina will not apply to the close clay soils of the Mississippi Delta country. The fact is that the opportunities for studies along this line are as numerous as are the types of soil and the variations in rainfall. To the extent that resources will permit, these investigations will be continued with respect to other soil types and localities.

One of the advantages that has long been claimed for tile drains is that they "warm" the soil. While it is not difficult to arrive at this conclusion from a theoretical standpoint, few satisfactory demonstrations based upon long-continued records have been made. The record kept by the bureau this year will therefore add an important contribution to the existing data on this subject. By the use of the soil thermograph a continuous record was kept for one year beginning May 1, 1921, on a tile-drained tract and on an adjoining undrained tract, on the college farm at Athens, Ga. The results showed that at a depth of 18 inches below the surface the average temperature of the drained soil was nearly 2° higher than that of undrained soil at the same depth. A similar record is now being kept at Athens and also on the experimental farm at Summerville, S. C., for a depth of 12 inches.

The amount of run-off from agricultural land and the flow of water under various conditions afford a field for research on which many times the funds available for such work might be expended with profit. Run-off is the very basis of drainage design. The success or failure of the system hinges on the decision as to how much water must be carried and how it shall be carried. This applies as well to the tile system installed by the individual farmer as to the great dredged ditches and floodways designed in connection with community projects affecting hundreds of landowners. The Little River drainage district in southeast Missouri, one of the largest in the country, affords unique opportunity for the study of the flow of water in floodways and determination of run-off from the drainage area. The floodway consists of parallel levees, some 1,200 feet apart, built to carry the hill water directly across the flat, intervening country to the Mississippi River. The spring of 1922 afforded an exceptional chance to study the flow in this floodway as affected by high stages of the Mississippi, and the bureau was fortunate to be able to take advantage of the opportunity. Before terminating this investigation it is hoped that a chance will be afforded to study the floodway under conditions of simultaneous high run-off from the hill land and low stage of the Mississippi. The complete data, when secured, will fill a gap in engineering knowledge necessary for the proper design of similar projects.

Other surface run-off data were collected through the keeping of continuous stage readings on certain streams in Alabama and North Carolina, the channels of which have been so gauged that the discharge at various stages is known. Continuous record of discharges from tile systems were kept in conjunction with records of rainfall and temperature on the college farm at Athens, Ga., on the State experimental farm at Summerville, S. C., and in Pitt County, N. C. These data will be invaluable in the future design of large and small systems to operate under similar conditions.

The investigation of the durability of tile under soil conditions existing in certain counties in southwestern Minnesota was continued. The cooperation given by the Minnesota department of agriculture and the State department of drainage and waters has afforded opportunity to extend the scope of the work so as not only to aim at defining the areas where the use of concrete tile—as at present manufactured—is not advisable, but also to carry on research that it is hoped will lead to the commercial production of concrete tile that will be highly resistant to the action of soil alkalis. In the summer of 1921 a laboratory to be devoted to this work was established at the University of

Minnesota. It is gratifying to be able to record here that this work has the approval and cooperation of the manufacturers of concrete tile in Minnesota. A marked improvement in the quality of commercial tile put out is already apparent.

A preliminary survey of the concrete-alkali situation in the Southeastern States was also made during the year. Further work in this section is planned.

One of the greatest problems of the individual farmer and of agricultural communities is soil erosion. The rich top soil, the loss of which from his field the farmer mourns to-day, is to-morrow the bane of his neighbor. In past years the bureau has given considerable study to surface erosion and gullying, the by-products of which present community problems that yearly are becoming more serious. The soil washed from thousands of cultivated fields ultimately is deposited in the large drainage outlets, often constructed at great expense, and decreases their efficiency. Until this problem shall be solved at its source, which is the farmer's field, communities will be put to large expense to maintain their drainage outlets. A number of methods of preventing and controlling gullies have been found to give good results, and these have been presented in the bulletin Gullies—How to Control and Reclaim Them.

The use of sedimentation basins to overcome the deposition of material in stream beds promises some success. These basins are made by diking off areas of flat land where the silt-laden tributaries debouch from the hills. The spreading out of the water in these diked areas results in a reduction of velocity and a deposition of at least a part of the silt. For three years the bureau has followed the action of a number of these basins in the Middle West. Measurements have been made of the rate of filling, the character of the deposited material has been noted, and beneficial effects on the stream below recorded. The problem is a complex one, but as a result of the study—to be continued over a number of years—the bureau expects to be able to make definite recommendations with regard to sedimentation basins that will be of great value.

Extension work in farm drainage is conducted in cooperation with the State extension services. In some States formal cooperative agreements are operative. In others, where the bureau has no drainage representative, each project is handled individually with the extension service. During the last fiscal year regular estension agreements were in effect in Alabama, Arkansas, Georgia, North Carolina, Tennessee, and West Virginia. The work consisted mostly of individual assistance given to farmers in connection with tile drainage and terracing layouts.

Mention should be made of assistance rendered drainage districts whose plans have been submitted to the bureau for review. Suggestions relating to such plans have been instrumental in saving thousands of dollars to the affected landowners.

## FARM ENGINEERING INVESTIGATIONS.

As the work of the bureau in connection with the investigation of farm engineering problems has become more widely known to the public the requests for information and assistance from farmers and others have been received in such numbers as to occupy the greater part of the time of the limited technical force available. It is a service that is of great value to the more or less isolated farmer who is without other means of securing information and to the many who do not know where to look even though other sources of information are accessible to them.

Much of the structural and mechanical engineering work of the year has been done in cooperation with or at the request of other bureaus of the department whose findings affect farm structures, machinery or equipment, and which for proper presentation require designs, either in the form of blue prints or as illustrations accompanying text matter. A number of farm structure and equipment designs were prepared for general distribution.

Plans of buildings to house the experimental and investigational work of other bureaus were prepared and a study was made for the purpose of enlarging the water supply at the Arlington Experimental Farm, and plans are also in preparation for a new heating and power plant for the farm.

One of the most important investigations conducted during the year is that which relates to the ventilation of barns, a project which was carried on in cooperation with the American Society of Agricultural Engineers. This matter of ventilation, so important to the maintenance of the health of stock, has not heretofore received the amount of scientific study its importance justifies. Very little precise information has been available with regard to the effect of temperature and wind upon the operation of a ventilation system, and the lack of such information has been responsible for a large percentage of expensive failures. The bureau's studies, which are still incomplete, have already supplied scientific data of great value to ventilating engineers, and a progress report in the form of a department bulletin has been prepared for publication.

Owing to the numerous inquiries regarding the construction of farm dams and the development of farm hydroelectric power plants, arrangements were made with the agricultural engineering department of the Virginia Polytechnic Institute for a cooperative investigation with a view to the publication of a bulletin which will bring home to many farmer owners of potential water power the energy that is going to waste and enable them to determine for themselves if an installation is practical, the power to be derived, and a rough estimate of the cost.

The text of a bulletin discussing the installation of multipipe warm air furnaces was practically completed. As one of a series of publications pertaining to farmhouse heating it should be of considerable interest to farmers confronted with a house-heating problem.

Concrete is almost universally used on the farm, and while something is generally known about its mixing, it is not always that a satisfactory or economical concrete is secured. This has been quite generally realized, as indicated by requests for information. Farmers' Bulletin 1279, Plain Concrete for Farm Use, is now in the hands of the printer and deals with the general principles of making, placing, and caring for plain concrete. This is the first of a contemplated series dealing with concrete construction on the farm.

There was also sent to the printer a joint publication prepared in cooperation with the Bureau of Entomology and designed to assist orchardmen who wish to make their own lime-sulphur spray.

Cooperative work with the same bureau in connection with the development of cotton-boll-weevil control was continued. The work of the year consisted largely of testing commercial dusting machines submitted to the laboratory, in advising with manufacturers in regard to machine design and construction, and in disseminating information and assisting prospective purchasers in the selection of suitable equipment. The interest shown by manufacturers who are considering the production of dusting machinery and of planters confronted with the boll-weevil problem was highly gratifying. A new development in the work is the use of airplanes equipped with dusting machines. Such experimental work as has been done indicates the desirability of further investigations and experiment with such equipment.

The replacement to a certain extent of horses and mules by mechanical power has become quite general on the farm and has created a demand from farmers considering the purchase of tractors and trucks for unprejudiced information. To meet the demand studies have been necessary in various sections of the country. These have been undertaken independently and in cooperation with the Office of Farm Management and Farm Economics and the Bureau of Animal Industry. As a result Farmers' Bulletin No. 1278, Tractors on Southern Farms, and Department Bulletin No. 997, The Cost and Utilization of Power on Farms Where Tractors are Owned, have been published and a Farmers' Bulletin, Corn Belt Farmers Who Own Motor Trucks, is with the printer.

In order to bring together in a comprehensive and related form the information obtained in the various farm power investigations that have been made in the Corn Belt, a series of bulletins was prepared bearing the following titles: Choosing the Tractor; Cost of Using the Tractor; Shall I Buy a Tractor; Changes Effected by the Tractor; What Tractors and Horses Do. The manuscripts which deal with Corn Belt conditions and which were prepared in cooperation with the Office of Farm Management and Farm Economics, were submitted for publication.

Department Circular 212, published during the year, is a report of the manufacture and sale of farm equipment in 1920. It was the intention to continue the compilation of such reports year by year, but the work was transferred to the Bureau of the Census, which will compile the information for the ensuing year.

## DISTRIBUTION OF SURPLUS WAR EXPLOSIVES.

In accordance with an act of Congress (Public, No. 7, 66th Cong., H. R. 5227) some 12,000,000 pounds of picric acid, a surplus war explosive, was turned over by the War Department to the Department of Agriculture for distribution to farmers as a means of encouraging land clearing. This picric acid is furnished to the farmer at the actual contract cost of drying, cartridging, packing, and shipping (6 cents per pound), plus a charge of 1 cent per pound to reimburse the State cooperating agency, usually the agricultural college, for its expense in connection with collecting individual orders and distributing carload shipments.

The plan has been very successful. It has placed a good agricultural explosive in the hands of farmers at a cost less than that of commercial dynamite and without doubt has been the means of furthering land clearing. Testimonials as to the efficiency of picric acid as an agricultural explosive have been uniformly favorable. Economic conditions during the last fiscal year have operated adversely to the distribution of picric acid; especially is this true of some of the Southern States, where the farmer, although desiring to obtain picric acid, was unable to take advantage of the opportunity. During the fiscal year 3,264,800 pounds of picric acid has been shipped to the various States, as follows:

| | Pounds. | | Pounds. |
|---|---:|---|---:|
| California | 72, 400 | Mississippi | 23, 000 |
| Connecticut | 20, 400 | Missouri | 65, 000 |
| Georgia | 37, 800 | Montana | 35, 200 |
| Idaho | 135, 100 | New York | 100 |
| Indiana | 24, 000 | North Carolina | 99, 700 |
| Iowa | 57, 300 | Ohio | 42, 000 |
| Kansas | 16, 100 | South Carolina | 17, 100 |
| Louisiana | 37, 300 | Tennessee | 44, 900 |
| Michigan | 637, 700 | Washington | 72, 600 |
| Minnesota | 1, 091, 300 | Wisconsin | 735, 800 |

# REPORT OF THE CHIEF OF THE BUREAU OF MARKETS AND CROP ESTIMATES.

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United States Department of Agriculture,
Bureau of Agricultural Economics,
*Washington, October 5, 1922.*

Sir: I have the honor to transmit herewith report of the work of the Bureau of Markets and Crop Estimates for the fiscal year ending June 30, 1922.

Respectfully,

Henry C. Taylor,
*Chief of Bureau.*

Hon. H. C. Wallace,
*Secretary of Agriculture.*

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On July 1, 1921, the Bureau of Markets and the Bureau of Crop Estimates were consolidated under the name of the Bureau of Markets and Crop Estimates. At the same time the department made recommendation in its estimates for the fiscal year 1923 that a further consolidation be effected by uniting the Bureau of Markets and Crop Estimates with the Office of Farm Management and Farm Economics. Congress gave favorable consideration to this recommendation, and in the act making appropriations for the Department of Agriculture provision was made for the creation of the Bureau of Agricultural Economics, to be charged with the exercise of all powers and the performance of all duties formerly imposed by law on the three separate bureaus. Although the latter consolidation did not actually take place until the end of the fiscal year covered by this report, an informal reorganization was effected by which related lines of work were brought into close cooperation and activities were regrouped in order to secure a more effective organization.

Especial attention has been given during the year to the prosecution of economic research studies, as it was felt that this work was fundamentally necessary as a basis for recommendations for improvements in marketing methods. The successful conduct of service and regulatory work also depends upon the bureau's possessing comprehensive and accurate information with regard to marketing conditions. Effort has been made to coordinate the economic studies of the bureau in such a manner that information can be furnished covering each phase of the whole process of production, marketing, and distribution.

Among the activities which have been given especial attention during the past year were the studies of the costs of marketing; the collection of information relative to agricultural competition of foreign countries with the United States and the demand for American farm products in foreign countries, and the effecting of arrangements for securing information as to condition and production of crops in various foreign countries; an analysis of the economic situation in the live-stock industry and the development of plans leading to the more orderly marketing of live stock; a study of fruit auction companies; the expansion of the work of collecting statistics of live-stock production; the formulation and perfecting of grades and standards for farm products; the inauguration of a shipping-point inspection on fruits and vegetables; the development of the radio news service; the inauguration of a grain news service; and the carrying out of the greatly increased activities under the United States warehouse act. A detailed report covering the various activities follows.

## DIVISION OF FRUITS AND VEGETABLES.

The work of the Division of Fruits and Vegetables, which was directed by Wells A. Sherman, included the following activities:

Marketing of fruits and vegetables.
Market news service on fruits and vegetables (including peanuts and honey).
Market inspection of perishable foods (fruits and vegetables).
Enforcement of the standard container act.

### MARKETING OF FRUITS AND VEGETABLES.

Under this project are included two groups of investigations, those relating to the formulation and promulgation of grades and standards for fruits and vegetables, conducted under the direction of H. W. Samson, and research studies relating to the marketing of fruits and vegetables, under the direction of A. D. Miller and Dr. A. E. Cance.

#### GRADES AND STANDARDS INVESTIGATIONS.

As a result of extensive field investigations and of tests under actual commercial conditions, Federal grades have now been formulated and recommended for the following 14 products:

Barreled apples.
Asparagus.
Cabbage.
Cauliflower.
Celery.
Cucumbers.
Lettuce.
Bermuda onions.
Northern-grown onions.
Peaches.
Strawberries.
Sweet potatoes.
Tomatoes.
White potatoes.

Tentative grades have also been recommended for shelled Spanish peanuts. Studies are now being made on the basis of which it is expected that grades for honey will be formulated.

Investigation of standards for packing various products has been continued. The general subject of preparing fruits and vegetables for market has also engaged the attention of this project. Material along these lines is being prepared for the use of extension workers, as well as for classroom work in agricultural colleges.

The technical staff has spent much time in the field assisting growers and shippers in the proper interpretation and use of grades which have been promulgated. This work was carried on both independently and in conjunction with State or local authorities. Demonstrations of the grades have been made at prominent shipping points in a number of States, and the number of requests is increasing for such educational and practical assistance. Much of this work has resulted from the inauguration of shipping-point inspection services by several of the States. It is of the utmost importance that uniformity be observed in the interpretation and application of the grades, so that they may have a national influence in the orderly marketing of farm products.

### RESEARCH STUDIES IN THE MARKETING OF FRUITS AND VEGETABLES.

A study is being made of the organized fruit auction companies, of which there are approximately 20 in the larger city markets. Although it is estimated that auction companies handled about $150,000,000 worth of fruit during the past year, very little is known of the details of their organization and the extent to which they differ in the functions performed or services rendered, or of their relative efficiency in the handling of different classes of products. The question of the extension of credits by auction companies and innumerable details connected with their business management need to be brought to light in order that their usefulness may be measured and that reforms in their control or methods may be brought about, if necessary.

An intensive study is being made of the subject of the financing of of the production of fruits and vegetables by distributors. The purpose of this study is to ascertain to what extent and in what regions growers are financed while producing a crop, either by distributors and dealers or by banks, stores, or fertilizer companies; what crops are so financed; what is the effect on distribution and prices; what is the effect on production; and what is the relation of such financing to growers' cooperative associations.

Studies are being made also which aim to secure detailed information on problems of production, supply, distribution, and consumption of various agricultural commodities. These studies will enable the department to furnish more timely and helpful forecast data to serve as a basis for intelligent decisions on the part of producers in the marketing of their products.

### MARKET NEWS SERVICE ON FRUITS AND VEGETABLES.

The division leader was assisted in this work by E. W. Stillwell.

The telegraphic market news service on fruits and vegetables has completed its seventh year of operation. During 1921 the program of shipment reports included 36 important fruits and vegetables, but this number was later reduced to 20, so that the work of the past fiscal year covered only the following commodities:

Apples.
Cabbage.
Cantaloupes.
Casaba melons.
Cauliflower.
Celery.
Grapes.
Honey Dews.
Lettuce.
Mixed deciduous fruit.
Mixed vegetables.
Onions.
Peaches.
Pears.
Spinach.
Strawberries.
Sweet potatoes.
Tomatoes.
Watermelons.
White potatoes.

On 14 of these products complete daily market reports were issued in season. On the remaining commodities only daily shipment information was published. The complete reports include carlot shipments by States, the arrivals, cars on track, jobbing prices, and general conditions in 10 or more of the leading markets, as well as the f. o. b. prices and other shipping-point information.

Car-lot movement reports were received during the year on nearly 735,000 cars of 24 of the principal fruits and vegetables. These reports were submitted by 1,275 division superintendents and other officials representing approximately 500 transportation lines.

At the opening of the year 1921 there were 14 market stations in operation in important consuming centers. Reduction of funds for this work made it necessary to close three of these branch offices, so that only 11 regular market stations were operated during the fiscal year 1922. The list of these offices follows:

Baltimore.
Boston.
Chicago.
Cincinnati.
Cleveland.[1]
Detroit.[1]
Kansas City.
Los Angeles.
Minneapolis.
New York.
Omaha.[1]
Philadelphia.
Pittsburgh.
St. Louis.

All of these offices except Los Angeles were connected with the leased wire system of the bureau. Communication with that city and with most of the 34 field stations in country districts was by commercial wire.

Temporary field stations were operated during the year 1921 at 34 points in principal producing sections, a decrease of 5 stations as compared with the preceding year. In the first six months of 1922, six additional stations were opened at points which did not have service in 1921. The news service had its own representatives in 25 different States. Many of the permanent branch offices in terminal markets served mailing lists of producers and shippers in near-by territory.

In the year ending December 31, 1921, approximately 5,200,000 mimeographed reports were issued at market stations and 1,600,000 from temporary field stations. The mailing lists at the market stations and at Washington included 32,600 individuals, while the field stations served nearly 27,000 persons.

A Weekly Market Review of Fruits and Vegetables has been issued regularly from Washington. This review analyzes the car-lot shipments of the week and the trend of prices in the various consuming and producing centers. It is distributed in mimeographed form to approximately 4,000 persons.

A short week-end review also is prepared and distributed by the department's press service to several press associations, thus reaching a large number of weekly journals having many thousands of subscribers. A monthly news story is sent to about 50 periodicals, mostly farm papers, which go to press late in the month.

The Weekly Summary of Carlot Shipments of fruits and vegetables continues to be a valuable adjunct of the News Service. This statistical report compares the movement of each product from the respective States of origin with the shipments of the previous week and with the corresponding period of the year before, and shows the total shipments to date this season and last. It is mailed from Washington to a list of 1,100 names.

In addition, many items of information are distributed by telegraph and telephone upon request of interested parties who pay the costs of transmission. Information is distributed by radiograph and radiophone, and through the department publication, Weather, Crops, and Markets. (This subject is treated at more length under the Division of Information.)

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[1] Discontinued.

Weekly reports on peanut marketing conditions have been continued, and have met with much favor by consumers and dealers.

Semimonthly reports on honey and beeswax are issued from the Washington office to a list of 3,500 names, and from Kansas City to about 1,700. This is an increase of approximately 73 per cent over the number receiving these reports last year. The service has been strengthened during the past year by the addition of new sources of information in producing areas.

Daily unload reports covering 10 commodities have been secured by representatives of the bureau located at 13 of the most important receiving points. These statistics furnish an index of the consuming capacity of various markets, as well as a report of the source of supplies. The information thus secured has been very valuable in answering inquiries for this type of information, and it is now being prepared for publication.

The value of the Market News Service has been demonstrated during the past year by the fact that agencies in various sections have entered into agreements with the bureau by which the local or State organizations pay the whole or a part of the expenses involved in order that the bureau may be able to extend this service to them.

### MARKET INSPECTION OF PERISHABLE FOODS (FRUITS AND VEGETABLES).

The division leader has been assisted in this work by F. G. Robb. This service has maintained offices in the following principal distributing markets of the country for the periods indicated:

Entire year: Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Detroit, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, St. Louis, San Francisco, and Washington.
Denver, Colo.: April, 1922–June, 1922, inclusive.
Fort Worth, Houston: September, 1921–February, 1922, inclusive.
Harrisburg, Wilkes-Barre: September, 1921–June, 1922, inclusive.
Louisville: July, 1921–November, 1922, inclusive.
Norfolk: September, 1921–May, 1922, inclusive.

At Columbus, Harrisburg, Los Angeles, Milwaukee, and Wilkes-Barre the inspection work has been conducted in connection with market news work, one employee handling both services. At Denver the inspection work was established in May in cooperation with the State of Colorado. At Norfolk and San Francisco, the few commercial inspections handled were made by men whose principal duties consisted of the inspection of fruits and vegetables for the Navy.

From the markets indicated above 192 additional designated markets were reached upon request. Approximately 95 per cent of all inspections, however, were made in the markets in which inspectors were located.

The following table shows the total number of commercial inspections handled by each office during the fiscal year 1922. This does not include inspections for the Navy or Marine Corps. The grand total of 31,207 inspections is about 31 per cent more than the total for the fiscal year 1921:

| Station. | Total. | Station. | Total. |
|---|---|---|---|
| Atlanta | 436 | Louisville | 80 |
| Baltimore | 864 | Memphis | 452 |
| Boston | 1,049 | Milwaukee | 480 |
| Buffalo | 609 | Minneapolis | 1,035 |
| Chicago | 4,120 | New Orleans | 684 |
| Cincinnati | 695 | New York | 4,262 |
| Cleveland | 1,324 | Norfolk [2] | 146 |
| Columbus | 253 | Omaha | 471 |
| Denver [1] | 16 | Philadelphia | 5,196 |
| Detroit | 1,061 | Pittsburgh | 4,375 |
| Fort Worth | 122 | St. Louis | 1,357 |
| Harrisburg [1] | 27 | San Francisco [2] | 5 |
| Houston | 99 | Washington | 536 |
| Indianapolis | 456 | Wilkes-Barre [1] | 136 |
| Kansas City | 835 | | |
| Los Angeles | 26 | Total | 31,207 |

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[1] Cooperative inspection work was not started at Harrisburg, Pa., until October, 1921; at Wilkes-Barre Pa., until September, 1921; and at Denver, Colo., until May, 1922.

[2] Most of the work at Norfolk and San Francisco is done for the Navy; relatively few commercial inspections are required at those points.

The inspections performed covered 91 products, but 71 per cent of all inspections were on potatoes, apples, grapes, peaches, oranges, onions, cabbage, lettuce, and tomatoes. Ninety per cent of these inspections covered full carloads, the remainder of the inspections covering from a few packages to one-half a car. In addition, 34,440,016 pounds of fruits and vegetables were inspected for the Navy and Marine Corps at eight naval stations. Of this quantity 2,181,009 pounds were rejected, and reductions were made for short weight and other reasons amounting to 160,608 pounds. Fees received for the inspection of fruits and vegetables during the year amounted to $121,575.13.

It was necessary to refuse over 2,000 requests for inspections in markets already established because of lack of men to perform the work requested. Hundreds of inquiries were received also from shipping points and nondesignated markets, while a number of large designated markets requested the continuous service of an inspector, stating that the value of the service was decreased because of the expense and delay incident to having inspections made by men who were stationed in some other market.

### ENFORCEMENT OF THE UNITED STATES STANDARD CONTAINER ACT.

The division leader was assisted in this work by H. W. Samson and H. A. Spilman.

During the past year visits were made to more than 60 package factories in 12 States. A number of wholesale dealers and State officials were called upon in connection with standardization work, and addresses relating to this work were made at several conventions.

Three specific complaints of violations of the standard-container act were investigated; one relating to Florida tomato baskets, a second connected with Indiana berry boxes, and a third regarding berry boxes from Michigan. The office work of this project was greatly increased during the year. Nearly 2,300 containers of various descriptions were submitted for official capacity tests, an increase of more than 1,800 over the preceding year. Sets of photographs illustrating standardization of containers were supplied to interested parties. Several leaflets were also issued in mimeographed form as follows:

"Outline of Present and Proposed Standardization of Fruit and Vegetable Containers."
"A Schedule of Recommended Dimensions for Berry Boxes and Till Baskets."
"A List of States Which Have Standardized Fruit and Vegetable Containers."

## DIVISION OF LIVE STOCK, MEATS, AND WOOL.

The Division of Live Stock, Meats, and Wool, which has been conducted under the direction of C. V. Whalin, includes the following activities:

Research studies relating to the marketing of live stock, meats, and wool.
Market reports on live stock, meats, and wool.

### RESEARCH STUDIES RELATING TO THE MARKETING OF LIVE STOCK, MEATS, AND WOOL.

The division leader has been assisted in this work by C. A. Burmeister, L. B. Burk, W. C. Davis, C. A. Harlan, and G. T. Willingmyre.

Greater progress was made in the investigational and research work of this division during the past year than in any previous year. Investigation of the marketing problems which had been abandoned temporarily during the war were resumed and many problems which had developed as a result of changed economic conditions were given attention. Because of the discouraging conditions prevailing in the live-stock industry at the opening of the past fiscal year, the division undertook to make a careful analysis of the economic phases of the live-stock industry. A thorough study was made of all available data, and the results of these studies were summarized in three reports which were used by the department committee which had been organized for the purpose of assisting the Joint Commission of Agricultural Inquiry in its investigation of this subject.

Discontent caused by the uneven progress of deflation in the various industries aroused much interest as to the final distribution of the consumers' dollar and prompted inquiries as to whether any particular interest in the chain of distribution was receiving an excessive share for services rendered. Investigations were conducted to obtain the information needed to determine the percentage distribution of the "consumers' meat dollar," and the analysis made was furnished the departmental committee appointed to assist the Joint Commission of Agricultural Inquiry.

Through cooperation with the buying and selling agencies in the live-stock markets in Chicago, information is being secured and tabulated showing the State origin, movement, and average weight of each grade of beef steers received, together with the average price paid and final disposition. Information is being tabulated also showing the percentage of each market class of sheep and lambs in the total receipts at Chicago and the average weight and price of these classes. Plans are under way to extend this service to Omaha and Kansas City. This information will become more valuable as it becomes cumulative, and eventually it should enable producers and feeders not only to plan their operations more intelligently but to regulate the movement of their stock to market.

An exhaustive study has been made of the history of the development of live-stock marketing in the United States. Information which will be of great value from a historical viewpoint has been assembled. This information is being prepared for publication in Yearbook articles on the cattle and swine industry.

Because of numerous complaints received from producers in the Southeastern States of unfair discrimination on the part of local slaughterers in the prices paid for soft or oily hogs as compared with prices paid for firm hogs, the division made an investigation to determine the facts. It was found that there was a lack of information with regard to the true market values of hogs which might be corrected by the establishment of a market-reporting service in this section. Plans for such a service are being given consideration.

Particular attention has been given during the past year to perfecting the market classes and grades for live stock and dressed meats. The development of these standards has been carried on in connection with the market-reporting service on live stock and dressed meats which was begun early in 1917, the tentative grades being used as the basis for the market reports. These standards have been thoroughly tested by the bureau and have been subjected to intensive study with a view to eliminating any weak features. Numerous conferences have been held with producers and members of the trade, and suggestions and recommendations have been invited in order that the standards as finally promulgated might meet the needs of the trade. The work of preparing these standards has now been completed. Illustrated bulletins describing the various classes and grades and defining terms are in course of preparation. Manuscript for a bulletin on Market Classes and Grades of Dressed Beef has been submitted for publication and similar bulletins will be submitted at an early date covering cattle, hogs, veal, lamb, and mutton, and pork carcasses and cuts and miscellaneous meat products. When available for public distribution these bulletins will enhance the value of the market news service, as the information embodied therein will greatly facilitate the interpretation of the market reports.

Progress has been made toward the adoption of standard containers for shipping meat and meat products. Educational work has been carried on by means of exhibits at the International Live Stock Show in Chicago and the various State fairs, and charts have been prepared for distribution which illustrate standard methods of cutting carcasses of the various meat animals into wholesale and retail cuts.

Intensive studies have been carried on with regard to the costs of marketing live stock. (This subject will be covered elsewhere in this report under the title Costs of Marketing.)

In connection with the research work on the costs of marketing live stock and meat, arrangements were made for a series of slaughtering and cutting tests at one of the slaughterhouses in Washington. These tests furnished information with regard to the weight of the carcasses and the weight of the edible and inedible by-products as compared with the live weight of the animal, and also more detailed information with regard to the various cuts in their relation to other cuts and to the carcasses from which derived.

Because of the slow decline in retail meat prices as compared with the general decline in wholesale prices, an investigation was made to ascertain the causes thereof. The investigation was conducted in nine New England cities and included studies of 54 retail markets divided into 10 large stores, 4 chain stores, 38 small stores, and 2 cooperative stores. The purpose of this investigation was to determine the relative efficiency in the operation of stores of the various types and the price variations in the different cuts of meats by grades.

The research work in wool marketing included investigations of methods and practices of handling and marketing wool and mohair and the development of standard classes and grades for these products. Attention was given also to demonstrations and extension work in grading and marketing wool.

The inability to market their wool at satisfactory prices caused the woolgrowers of Colorado to request the bureau to make a special study of their marketing problems. The representative of the division assigned to the study spent five weeks in that State where he attended 18 meetings of woolgrowers, held 10 conferences with prominent woolgrowers and business men, and conducted four grading demonstrations before classes at the State agricultural college. A complete report was prepared on the methods and practices of marketing and grading wool within that State.

Much progress was made during the year in the wool standardization work. More than 500 sets of the tentative wool grades have been prepared and distributed among wool manufacturers, dealers, growers, agricultural colleges, and others interested, every State being represented.

### MARKET REPORTS ON LIVE STOCK, MEATS, AND WOOL.

The division leader was assisted in this work by W. C. Davis, C. E. Gibbons, E. W. Baker, and J. A. Burgess.

The market-reporting service on live stock and meats has been developed to the point where it is practically standardized. The service covers approximately the same territory as that served during the previous year, as there can be no material expansion made unless a larger appropriation is made for this purpose.

It is gratifying to report, however, that due to the increasing public interest in this service and the growing demand for market information, the various news disseminating agencies, such as press associations, commercial telegraph companies, trade journals, newspapers, and commercial radio broadcasting stations, all desire to include the bureau's market reports in the trade information which they furnish to the public. By cooperating with these agencies the division has not only been able to obtain wider dissemination of its market information than ever before, but at less cost and with greater efficiency and speed. Utilizing outside agencies for the dissemination of this information also opens possibilities for a reduction in the number of mimeographed reports distributed, thereby permitting a considerable reduction in the cost of the service.

### DISSEMINATION OF MARKET NEWS BY RADIO.

The development of the radio, particularly the radio telephone, probably has been the greatest stimulus to interest in the market-reporting service during the year. The division has made the fullest use of radio broadcasting facilities as far as they have become available.

The following program, which is broadcasted daily from the Arlington and Post Office stations at Washington, indicates the kind of live-stock-market information prepared in this division for dissemination by radio:

8.30 a. m., estimated receipts at seven markets.
11 a m., opening hog markets, Chicago and East St. Louis.
11.30 a m., estimated receipts at nine markets and opening hog markets. Chicago and East St. Louis.
2 p. m., Chicago and East St. Louis market conditions and prices.
2.45 p. m., Chicago closing market conditions and live-stock prices.
3 p. m., weekly and daily marketgram.
3.30 p. m., closing live-stock markets, Chicago and East St. Louis.

In addition to the above program special reports pertaining to particular markets are broadcasted by various commercial broadcasting stations in territory contiguous to those markets. (See Division of Information.)

### MIMEOGRAPHED REPORTS DISTRIBUTED.

Minor changes in the context and style of the mimeographed reports are made from time to time as conditions warrant. A device has been adopted which makes it possible to increase by 36 per cent the number of lines on a page. This results in a material saving.

The mimeographed reports are sent free of charge to anyone making specific request for them. The mailing lists are circularized every six months in order to limit the distribution of the reports to those manifesting an actual interest in them. At the close of the fiscal year there were approximately 13,000 names on the lists, many of the subscribers being listed to receive both daily and weekly reports. The mimeographed reports available for distribution are as follows:

### DAILY REPORT OF MEAT-TRADE CONDITIONS AND WHOLESALE PRICES (WESTERN DRESSED MEATS).

This report shows prices, supply, demand, and trend of the market for western dressed fresh beef, veal, pork, lamb, and mutton in Boston, Chicago, New York City, and Philadelphia. It is issued daily except Saturday from all of the local offices of the division, including the foregoing cities and East St. Louis, Kansas City, Omaha, South St. Joseph, Mo., and St. Paul. At Boston, New York, and Philadelphia it is combined with the daily report of live-stock markets described below.

### DAILY REPORT OF LIVE-STOCK MARKETS.

This report shows prices, supply, demand, and trend of the market for cattle, calves, hogs, and sheep at Chicago, East St. Louis, Kansas City, Omaha, South St. Joseph, Mo., and St. Paul. It is issued daily from all of the local offices of the division in the foregoing cities and, in addition, is issued in combination with the daily report of meat-trade conditions and wholesale prices from the offices at Boston, New York, and Philadelphia.

### WEEKLY REVIEW OF MEAT-TRADE CONDITIONS.

This report, which is issued each Friday from all the local offices of the division, reviews the week's trading in western dressed fresh meats at Boston, Chicago, New York City, and Philadelphia. At the three eastern cities—Boston, New York, and Philadelphia—this review is issued in combination with a brief review of live-stock market conditions at Chicago, Kansas City, East St. Louis, and Omaha. A similar review is also published in Weather, Crops, and Markets.

### WEEKLY REVIEW OF LIVE-STOCK MARKETS.

This report is issued each Thursday at Chicago, East St. Louis, Kansas City, Omaha, South St. Joseph, Mo., and St. Paul. It reviews market conditions for the week at the market where released and includes detailed information as to receipts, demand, and prices paid for the various classes and grades of live stock. A less detailed review of conditions at Chicago, East St. Louis, Kansas City, South St. Joseph, Mo., and Omaha is released each Friday at Boston, New York, and Philadelphia in combination with the weekly review of meat-trade conditions.

### WEEKLY REVIEW OF ST. PAUL LIVE-STOCK MARKET FOR COUNTRY NEWSPAPERS.

In order to meet the demand from country newspapers in the territory which contributes live stock to the St. Paul market, a weekly review, summarizing live-stock market conditions and prices at that market, is prepared semiweekly by the division's representative at St. Paul in cooperation with a representative of the Minnesota Department of Agriculture. This review is mimeographed and sent to weekly and small daily newspapers in Minnesota, North and South Dakota, and Montana for publication. This service has been highly commended by both the newspapers receiving it and their readers. This method of disseminating information is recommended by this division because of its low cost and efficiency.

### WEEKLY REVIEW OF BRIGHTON LIVE-STOCK MARKET.

A review similar to that prepared at St. Paul for distribution to country newspapers is prepared each week covering live-stock market conditions and prices at the Brighton stockyards which are located near Boston. This review is prepared by the Boston representative of the division for distribution through the New Hampshire and Vermont departments of agriculture. It is sent to newspapers, live-stock buyers, and others interested in that market. The information contained therein is also broadcasted by radio.

### MONTHLY SUMMARY OF COLD-STORAGE HOLDINGS OF FROZEN AND CURED MEATS.

This summary shows the stocks of frozen and cured beef and pork, including lard, and frozen lamb and mutton, in storage on the first of each month. It is prepared in the Division of Statistical and Historical Research, and released from the branch offices of the Live Stock, Meats, and Wool Division in Boston, New York, Philadelphia, Chicago, East St. Louis, Kansas City, Omaha, and St. Paul on the 15th of the month following the date covered. It is primarily for the press and trade organizations, but is sent regularly to anyone requesting it. The figures are also included in the monthly report of cold-storage holdings published in Weather, Crops, and Markets.

### MONTHLY SUMMARY OF COLD-STORAGE HOLDINGS OF FROZEN AND MILD-CURED FISH.

This summary, which is also prepared in the Division of Statistical and Historical Research, shows the stocks of frozen and mild-cured fish in storage on the 15th of each month. It is released from the branch offices of the Live Stock, Meats, and Wool Division in Boston, New York, Philadelphia, Chicago, East St. Louis, Kansas City, Omaha, and St. Paul at the end of each month, following the date covered. It is primarily for the press and trade organizations, but is sent regularly to anyone requesting it. It is also published in Weather, Crops, and Markets.

### SPECIAL REPORTS ON LIVE-STOCK MOVEMENTS, WEIGHTS, AND PRICES ISSUED FROM CHICAGO.

In connection with the statistical studies being made at Chicago to ascertain the seasonal marketing of live stock by classes and grades, information is compiled and published each week showing the following:

1. Receipts of cattle at each of seven markets during the crop season for each of the past three years.
2. Beef steers at Chicago sold out of first hands for slaughter, segregated by grades. This report shows the per cent represented by each grade, together with the average weight and average price and comparisons for the preceding week.
3. Numbers of stocker and feeder cattle shipped from 12 leading markets into each of seven Corn Belt States from January 1 to date, together with comparison for the corresponding periods of the two years immediately preceding.
4. Number, average weight, and average price of stocker and feeder steers shipped from Chicago during the most recent week, segregated as to five weight ranges, together with comparisons for the preceding week.
5. Receipts of hogs at each of seven middle western markets during the crop year, with comparisons for 1920 and 1921.
6. Receipts of sheep and lambs at each of seven important markets during the crop year, with comparisons for the two years immediately preceding.
7. Percentage of each kind (lambs, ewes, yearlings, and others) in the Chicago receipts for the most recent months.
8. Number of feeder sheep and lambs shipped from 12 important markets into each of seven States from January 1 to date, together with comparisons for 1920 and 1921.

This information is incorporated in the Saturday issue of the daily live-stock report and is a valuable feature of that report. It enables the reader to visualize the relative volume of the supply of beef cattle according to grade and the relative condition of the stockers and feeders going back to the country for further finishing; also, the States to which one must look for supplies of finished cattle and sheep during the next few months.

### REPORTS OF ACTUAL SALES AT SOUTH ST. PAUL.

During the past spring, in cooperation with the Minnesota Department of Agriculture, and the Minnesota College of Agriculture, arrangements were made whereby on June 15 the St. Paul office of this division supplemented its regular daily report of the St. Paul live-stock market with reports of actual sales of steers by grade.

### MARKET INFORMATION INCLUDED IN WEATHER, CROPS, AND MARKETS, ETC.

This division cooperates with the Division of Information in the preparation of material for press releases, reports for trade papers and for publication in Weather, Crops, and Markets.

### EXTENSION OF LIVE-STOCK MARKET NEWS SERVICE.

Through cooperative arrangements with the Missouri State Department of Agriculture the leased wire service of the bureau was extended to include St. Joseph, Mo., and a reporting office was established there in March, 1922. Arrangements were made also just before the end of the fiscal year in cooperation with the California State Department of Agriculture to inaugurate a special live-stock market reporting service at San Francisco and Los Angeles for the benefit of the live-stock producers of California and adjoining States.

## DIVISION OF DAIRY AND POULTRY PRODUCTS.

The work of the Division of Dairy and Poultry Products has been directed by Roy C. Potts. The following activities are included in this division:

Research studies relative to the marketing of dairy and poultry products.
Market news service on dairy and poultry products.
Inspection of butter.

### RESEARCH STUDIES RELATIVE TO THE MARKETING OF DAIRY AND POULTRY PRODUCTS.

The research studies covering problems relating to marketing dairy and poultry products have for their purpose the gathering and dissemination of information which may aid in improving marketing methods, conditions, and practices and thereby reduce the costs of marketing and distributing these commodities.

A study of the methods of operation and form of organization of 15 producers' cooperative milk-marketing associations which had been begun in the previous year was continued. The results of these studies have been embodied in a bulletin prepared for publication.

Special attention has been given to the subject of market standards and grades for eggs. After careful investigation of the commercial grades now in use in the large wholesale markets of the country, tentative standards and grades were formulated and have been submitted to the trade for approval. Thus far the views of the trade have been very favorable to the tentative grades. The matter of establishing rules and regulations covering the inspection of eggs is being given attention. Preliminary investigations are being undertaken for the purpose of establishing grades for live and dressed poultry.

Assistance has been given to State marketing bureaus in the formulation of grades for eggs and for cheese, and bulletins have been prepared for publication on various phases of the marketing of dairy and poultry products. Demonstrations have been made of better methods of grading and packing eggs, and information has been given to producers, shippers, and others regarding improved methods of marketing dairy products.

### MARKET NEWS SERVICE ON DAIRY AND POULTRY PRODUCTS.

The division leader has been assisted in the market news-service work by L. M. Davis.

This work has proceeded along the lines laid down in former years, but a constant effort has been made to secure wider dissemination of the available information. Branch offices have been maintained at the following points: New York City, Chicago, Philadelphia, Boston, San Francisco, Minneapolis, and Fond du Lac.

Daily and weekly market reports have been issued as a part of the telegraphic news service as follows:

Daily Market Report (butter, cheese, eggs, and dressed poultry).
Weekly Butter Market Review.
Weekly Cheese Market Review.
Monthly Cold Storage Report.
Noon Report on Butter and Egg Markets.
(For distribution to local trade by messenger.)

These reports were issued at all branch offices and at Washington to a mailing list of approximately 10,000 names, representing all classes of trade and others who were interested. All mailing lists in the division are kept active by circularization once each year.

The branch offices of the division have continued to be large distributors of market news by telephone and otherwise to members of the local trade and to some extent by commercial wire to persons interested who pay for this special service. Telegraphic "flash" reports covering morning trading on the New York and Chicago markets have been improved in nature and in manner of handling, and represent a service which has met a special demand from the wholesale trade in the various markets where offices are located.

The following monthly reports have been issued from the Washington office:

Monthly Condensed and Evaporated Milk Market Report (contains buying and selling prices, stocks, and exports).

Monthly Powdered Milk Market Report (similar to preceding but covering powdered milk).

Monthly Fluid Milk Market Report (producers' prices, and wholesale and retail prices in more than 125 of the larger and more important cities of the United States).

Monthly Export Report (exports of butter, cheese, eggs, condensed and evaporated milk, powdered milk, and butter substitutes).

The mailing list for distribution of this group of reports includes approximately 9,000 names.

A quarterly report of dairy products manufactured is compiled from schedules received from more than 9,000 concerns manufacturing dairy products. This report covers 40 commodities and shows the amount manufactured each month. This report, as well as other special reports, is printed in the department publication Weather Crops, and Markets.

### INSPECTION OF BUTTER.

The division leader has been assisted in this work by C. W. Fryhofer.

Market inspection of butter has been maintained during the past year at Boston, Chicago, New York, Philadelphia, and Washington, D. C. On February 1, 1922, the service was extended also to the San Francisco market. The total number of inspections of butter shows an increase of nearly 50 per cent over the previous year. An amount of $7,052.30 has been returned to the Treasury as miscellaneous receipts from fees collected for this service.

## DIVISION OF HAY, FEED, AND SEED.

The work of the Hay, Feed, and Seed Division was directed by W. A. Wheeler and included the following activities:

Hay, feed, and seed marketing studies.
Hay standardization.
Market news service on hay, feed, and seed.

### HAY, FEED, AND SEED MARKETING STUDIES.

The hay-marketing studies were conducted by G. A. Collier, the feed investigations by G. C. Wheeler, and the seed investigations by G. C. Elder and J. E. Barr.

Methods of marketing hay, millfeeds, cotton seed, cowpeas, and broom corn were studied carefully with a view to offering helpful suggestions to buyers and sellers of these commodities. These suggestions and other information are incorporated in four bulletins prepared during the year.

This project cooperated with the War Department in drafting regulations for weighing hay and rendered assistance to New York hay exchanges and associations and to the State department of agriculture, in outlining steps necessary for the improvement of marketing conditions in New York City.

Seed production maps were prepared from census data, and information on the effect of delinting cotton seed for planting purposes was obtained. This latter information is to be used in a proposed bulletin on "Delinting and Recleaning Cotton Seed for Planting Purposes."

### HAY STANDARDIZATION.

The hay standardization work under the immediate direction of H. B. McClure consisted of tabulating the data accumulated during the previous year and formulating tentative grades for timothy, clover, timothy and clover mixed, mixed grass and timothy, and grass mixed hay. A complete exhibit of these grades has been prepared for display at conferences, conventions, terminal markets, and elsewhere.

Field studies were conducted at East Lansing, Mich.; Hart, Mich.; Ithaca, N. Y.; Elyria, Ohio; and Arlington, Va., and 622 samples were collected for color and chemical analyses.

New laboratory equipment devised and built consists of a conditioner for preparing samples for separation analyses, and racks for displaying exhibits showing results of separation analyses, interpretation of grades by the trade, and the tentative Federal grades. Numerous charts, graphs, and colored drawings have been made to explain laboratory methods.

### MARKET NEWS SERVICE ON HAY, FEED, AND SEED.

This project under the immediate direction of G. C. Edler and G. A. Collier obtained information on prices, supply, demand, movement, etc., of hay, feed, and seed by telegram and letter from paid and voluntary correspondents at important producing, distributing, and consuming points. Weekly hay and feed data were obtained regularly from 21 of the principal markets of the country. The commodities included were: Hay—timothy, clover, alfalfa, prairie and grain hay; straw; feeds—bran, wheat and rye middlings, cottonseed and linseed meal, hominy and gluten feed, peanut and velvet bean meal, dried beet pulp; seeds—clover (chief varieties), grass, millet, forage sorghum seeds, seed grains.

Hay and feed information was disseminated daily except Tuesday through the marketgrams and fuller reports on hay, feed, and also seed were furnished weekly to Weather, Crops, and Markets. In addition to the regular weekly review published in Weather, Crops, and Markets from January 1 to June 1 of conditions prevailing in the seed trade at New York, Baltimore, Richmond, Buffalo, Toledo, Chicago, Louisville, Minneapolis, St. Louis, Kansas City, Denver, and Salt Lake City, reports on the outlook, movement, shipment, and prices of seeds were published throughout the summer and fall when the bulk of the seed crops were moving from grower to dealer. Special articles on hay and feed of timely interest to producers, consumers, and dealers were prepared for Weather, Crops, and Markets and the department's press service.

Only two branch offices, at Chicago and Fort Worth, were operated throughout the year. The Chicago office transmitted detailed reports on the Chicago market to the Washington office three or more times a week. The broom corn reporting service was conducted from Fort Worth and from temporary stations in Oklahoma and Texas during the active movement of this crop.

## DIVISION OF COTTON MARKETING.

The work of the Division of Cotton Marketing, under the supervision of W. R. Meadows, is divided into the following activities:

1. Enforcement of the United States cotton futures act, which is divided into three separate projects, as follows:
   (a) Classification of cotton.
   (b) Future and spot market investigations and cotton price quotations.
   (c) Preparation and distribution of the official cotton standards.
2. Investigation and demonstration of cotton standards.
3. Cotton testing.
4. Cotton marketing demonstrations.
5. Cotton handling investigations.

### ENFORCEMENT OF THE UNITED STATES COTTON FUTURES ACT.

#### CLASSIFICATION OF COTTON.

The division leader was assisted in this work by F. W. Knight.

In accordance with the amendments of March 4, 1919, to the United States cotton futures act, all cotton delivered on future contracts must be classified by officers of the Department of Agriculture. In addition, the rules and regulations under the act provide that any owner of cotton who has under consideration the advisability of tendering it for delivery on a section 5 contract may secure the opinion of the board of cotton examiners as to the classification of samples of such cotton, by submitting the samples to the board and paying the required fee. The informal classification does not obviate the necessity for the regular classification if the cotton is presented for certification for delivery.

During the year 234,148 bales of cotton were classified by the boards of examiners at New York and New Orleans in the regular classification work; 43,384 bales were resubmitted to the boards for review; and in the review the classification of 3,724 bales was changed. In the preliminary sample classification work 7,711 samples were classified.

During the year the sum of $87,902.98 was collected as classification fees and from sales of loose cotton, and was deposited to the credit of the revolving fund maintained for the conduct of the work. Disbursements during the year amounted to $73,245.75. No changes were made in the fees.

### FUTURE AND SPOT MARKET INVESTIGATIONS AND COTTON PRICE QUOTATIONS.

The division leader was assisted in this work by A. M. Agelasto and B. B. Oastler.

The purpose of this work is to secure accurate quotations on cotton and give them the widest possible publicity. The cotton price quotation service has been maintained in the five districts for which Charlotte, Atlanta, Memphis, New Orleans, and Dallas are headquarters. During the period of heavy movement of cotton to market, October to March, a separate district was made of the State of Oklahoma, with headquarters at Oklahoma City. Reports of purchases and sales of cotton were gathered from country buyers, country merchants, dealers, brokers, commission merchants, factors, mills, and others who buy or sell cotton in important country markets and concentration points throughout the belt. On the basis of these reports weekly bulletins were prepared and published, showing the prices at which the various grades of cotton were actually bought and sold. The information contained in the bulletins can be obtained by telephone and telegraph by any person who requests the service and pays the transmission expense involved.

Several newspapers and periodicals in the South, having a combined circulation of over a million copies, are cooperating in this work by publishing each week reports of sales of cotton and prices at interior markets, which reports are furnished to them by the field offices of the bureau. In this way the quotation service is made available to a very large number.

In addition to the weekly bulletins, information regarding cotton prices and the cotton market in general was broadcasted daily by radio during the last half of the year. Plans are at present being made for the more extensive use of the radio for broadcasting information in the future.

### PREPARATION AND DISTRIBUTION OF THE OFFICIAL COTTON STANDARDS.

The division leader was assisted in this work by H. C. Slade.

The number of practical forms of the official cotton standards prepared and sold to the trade during the year were as follows:

Seventy-six full sets for grade and color for American upland cotton; 199 fractional sets for grade and color for American upland cotton; 10 full sets for grade for American Egyptian cotton; 4 fractional sets for grade for American Egyptian cotton; 6 full sets for grade for Sea Island cotton; 13 full sets for length of staple; 456 separate types for length of staple in addition to the full sets.

To meet a definitely established need of the trade, the Secretary of Agriculture on August 4, 1921, promulgated standards, represented by physical types, for the staple lengths $1\frac{1}{16}$ inches, $1\frac{3}{16}$ inches, and $1\frac{5}{16}$ inches. A full set of the official cotton standards for length of staple for which physical types now exist consists of the following 12 lengths, expressed in inches: $\frac{3}{4}$, $\frac{7}{8}$, 1, $1\frac{1}{16}$, $1\frac{1}{8}$, $1\frac{3}{16}$, $1\frac{1}{4}$, $1\frac{5}{16}$, $1\frac{3}{8}$, $1\frac{1}{2}$, $1\frac{5}{8}$, and $1\frac{3}{4}$. The descriptive standards for the other lengths of staple remain unchanged. During the months of March, April, and May an inspection was made of the sets held by various markets in the South, and numerous cancellations were found necessary.

Acting favorably upon this bureau's recommendations, the Secretary of Agriculture on July 26, 1922, promulgated new standards for grade and color for American upland cotton, new standards for American Egyptian cotton, and new descriptive standards for spotted, light stained, and gray upland cotton.

During the fiscal year the sum of $8,603.80 was collected from the sale and revision of practical forms of the standards, which amount was covered into the Treasury as miscellaneous receipts. In addition the sum of $18,582.79 was received from sales of loose and rejected cotton, and was deposited to the credit of the revolving fund established and maintained for the purchase of cotton for use in preparing standards.

### INVESTIGATION AND DEMONSTRATION OF COTTON STANDARDS.

The division leader was assisted in this work by George Butterworth.

The principal activities of this project were conducted in cooperation with the project cotton-marketing demonstrations. The leader of the project was furloughed for about six months during the year to the War Finance Corporation, to supervise the classification of American-Egyptian cotton on which loans were requested from the War Finance Corporation. This work was done at Phoenix, Ariz.

A careful study of American Egyptian cotton of the growths of 1920 and 1921 was made at Phoenix, and it was found that there had been a decided change in the color of the cotton since the promulgation of the original standards in 1918. Accordingly, the bureau recommended that the standards be changed so as to make them more fully representative of recent crops, and on July 26, 1922, the Secretary promulgated the new standards which will become effective on August 1, 1923.

Methods are being considered for the determining of exact strength of staple, and a mechanical test which will be a positive determination regarding the strength of staple is being developed. A study was made of cotton fibers, both microscopically and photomicrographically, as to their individual strength, spirality, and diameters. Microscopic studies are made of immature staple, gin cut, and reginned cotton, with a view to standardization. Apparatus and laboratory equipment are expected to arrive from abroad at an early date, when activities will go forward along this line of investigation.

### COTTON TESTING.

The division leader was assisted in this work by W. G. Blair.

Investigations have been made (1) to determine the relative spinning value of three different varieties of cotton grown at Bard, Calif., by the Bureau of Plant Industry during the season of 1920; (2) to determine the comparative spinning value of Pima and Sakellaridis cotton grown in California; and (3) to determine the comparative spinning value of cotton compressed to different densities. Laboratory tests were made to determine the strength of individual fibers and yarn in connection with the manufacturing tests. The spinning tests were conducted during the summer of 1921 at the North Carolina State College of Agriculture and Engineering, Raleigh, N. C., and from the last part of August to the present time at the Clemson Agricultural College, Clemson College, S. C. The laboratory tests were made in the cotton-testing laboratory at Washington.

The results of the spinning tests on the three varieties grown at Bard, Calif., and on the Pima and Sakellaridis cotton have been reported to the Bureau of Plant Industry for use in its cotton-breeding work. The results of the spinning tests of cotton compressed to different densities have been prepared for publication. The results of these tests showed that:

> Compressing cotton to standard or high density in a dry or normal condition is not injurious to its spinning value.
>
> Compressing cotton in a damp condition to high density either increases the percentage of waste or reduces the breaking strength of the yarn, or may do both.
>
> Compressing cotton into a round bale with a hard core reduces the strength of the yarn about 7 per cent. If the round bale were to be run continuously in cotton mills, special opening equipment would be desirable.

### COTTON-MARKETING DEMONSTRATIONS.

The division leader was assisted in this work by G. S. Meloy.

In cooperation with the extension service of several States, the Division of Cotton Marketing continued to give cotton growers instruction in the grading of their cotton, factors of value in cotton were explained, and methods of marketing and improving the grade and character of the cotton produced were fully explained and demonstrated.

During the past year 30 communities formed organizations for the marketing of their cotton, as follows: Six in North Carolina, 4 in South Carolina, 5 in Mississippi, and 15 in Texas. Over 110,000 bales were classed in these communities. According to reports received the immediate financial profits to the growers from this work ranged from one-half cent to 6 cents a pound, depending upon the particular local marketing conditions and whether the growers sold individually or collectively.

The placing in a community of a man competent to classify cotton gives the cotton buyers better assurance as to the quality of the cotton produced, with the result that they can better afford to pay true values than to deal on the wider margins of safety on which cotton trading generally is done.

Through an understanding with the association, this bureau was enabled to study the operations of the Oklahoma Cotton Growers' Association during the whole of its first season and has collected much data for further study. In Arkansas the work was confined to a study of the varieties of seed planted in relation to the character of the cotton produced, the introduction of pure seed of varieties found to be adapted to the different sections of the State, and a study of the ginning, storage, and compressing facilities of the State.

During the year a course of illustrated lectures was given by the project leader on the production, classification, handling, marketing, and manufacture of cotton at the agricultural colleges of North Carolina, Tennessee, Mississippi, Louisiana, and Alabama, and at the George Peabody Institute, of Nashville, Tenn. The lectures covered a period of one week at each institution and a total of about 5,000 students and prospective teachers were reached. The course was designed to illustrate the relationships between the different branches of the cotton industry.

A manuscript on "Coordination in the cotton industry" was submitted during the year for publication.

### COTTON-HANDLING INVESTIGATIONS.

The division leader was assisted in this work by R. L. Nixon.

Two series of tests or experiments known as the "gin-samples test" and the "weather-damage test" have been conducted, in the course of which many data have been collected for publication. In the first-mentioned tests comparison was made of samples of cotton before baling and samples of cotton after baling for the purpose of determining the practicability of grading cotton from samples drawn at the gin versus samples subsequently drawn out from the bales. This series of tests has been completed, and the data has been prepared for publication and the manuscript is in process of review.

In the second-mentioned tests bales of cotton were exposed in various positions and under various conditions for the purpose of determining the losses which accrue on account of the improper storage or lack of storage of cotton.

The information secured under the first-mentioned tests appears to warrant the conclusion that the adoption of gin sampling, if some method of preserving identity of samples could be devised, would bring about marked economies in handling cotton. That secured in the second-mentioned tests has enabled the bureau to show the producer and handler of cotton the tremendous losses which are sustained annually by failure to protect cotton properly from the weather and how such losses may be avoided.

A set of lantern slides and lectures on "Handling cotton" has been prepared for distribution through the States Relations Service.

## GRAIN DIVISION.

The work of the grain division was conducted under the supervision of H. J. Besley and included the following activities:

Enforcement of the United States grain standards act.
Research studies of the handling, marketing, and standardization of grain.

### ENFORCEMENT OF THE UNITED STATES GRAIN STANDARDS ACT.

During the past year the enforcement of the grain standards act was carried on under the direction of the division leader, assisted by E. J. Murphy, R. T. Miles, and O. F. Phillips.

#### ADMINISTRATION.

Under general direction from Washington the work of enforcing the grain standards act was administered in the field through (1) general field headquarters, Chicago; (2) Pacific coast headquarters, Portland, Oreg.; (3) five division supervisors with headquarters at New York, Indianapolis, Chicago, St. Louis, Kansas City; (4) 34 district offices of Federal grain supervision located at the principal grain markets throughout the country, and two branch offices.

#### STATUS OF OFFICIAL GRAIN STANDARDS OF THE UNITED STATES.

Standards for shelled corn, wheat, and oats were in force during the year. The standards for corn were made effective December 1, 1916, for wheat July 1, 1917, and for oats June 16, 1919.

The work devolving upon the bureau through the operation of this act has increased enormously during the past year. This is especially true of the appeals handled by the grain supervisors from inspections originally performed by licensed inspectors. During the year, 31,689 appeals, or approximately three times as many as the preceding year, were handled by offices of Federal grain supervision. Of this number, 781 went to board appeal. In addition to the handling of appeals on complaint of parties to commercial transactions, supervisors work in close contact with licensed inspectors, aiding them in inspection problems. A total of 175,896 supervision samples were handled during the year to check the work of the inspectors in order to secure correct and uniform application.

The following tables give in detail data covering appeals handled during the past year:

(1) Number of appeals filed—all grains combined and for each grain separately:

| | |
|---|---|
| Corn | 4,849 |
| Wheat | 25,592 |
| Oats | 1,248 |
| Total filed | 31,689 |

(2) Number and percentage of appeals sustained—all grains combined and for each grain separately:

| | Number. | Per cent. |
|---|---|---|
| All grains | 10,971 | 34.6 |
| Corn | 1,478 | 30.4 |
| Wheat | 9,214 | 36.0 |
| Oats | 300 | 24.0 |

(3) Number and percentage of appeals not sustained—all grains combined and for each grain separately:

| | Number. | Per cent. |
|---|---|---|
| All grains | 20,718 | 65.4 |
| Corn | 3,362 | 69.6 |
| Wheat | 16,378 | 64.0 |
| Oats | 948 | 76.0 |

(4) Number of board appeals called—all grains combined and each grain separately:

| | |
|---|---|
| Corn | 69 |
| Wheat | 675 |
| Oats | 37 |
| Total all grains | [1] 781 |

(5) The fees for the 20,718 appeals which were not sustained amounted to $54,038.89. No charges are made for the sustained appeals.

The steady increase in the volume of work to be performed made some curtailment of the service necessary. In order to avoid breaking down the efficient organization which had been perfected, it was decided to contract by closing a number of field offices. Plans to close four offices were under way at the end of the year, although decided protests against such action were made by trade organizations and individuals in the markets affected.

Minor changes in the standards for corn and wheat became effective during the year. In the corn standards the factor foreign material and cracked corn is to be determined by the use of a sieve having perforations twelve sixty-fourths inch instead of fourteen sixty-fourths inch in diameter.

In the wheat standards, the factor "bright" was eliminated from the No. 1 grade of all classes of wheat.

Because of requests received from certain interests in the central northwest for changes in the Federal grades, a thorough investigation was made of the standards for hard red spring and durum wheat, especially of their application at country marketing points. After much study it was decided that the results sought to be accomplished could be attained by certain changes in the rules covering inspections performed by licensed inspectors. Accordingly amendments to the regulations of the grain standards act were prepared and promulgated, to become effective during the next crop movement. In order that the Federal grades might be better understood, an extensive "Know your own wheat" campaign has been conducted in cooperation with the extension directors and other agencies in the States of Minnesota, North Dakota, and South Dakota. A price-reporting system designed to furnish producers and country shippers with comprehensive information regarding market conditions and prices at terminals was also inaugurated at Minneapolis for the purpose of rendering further assistance to the wheat interests in that section.

Meetings and conferences were held also in the Pacific Northwest with producers, dealers, and State officials regarding changes recommended in the grades for white wheats grown in that section, with the result that the standards were amended to combine the classes common white and white club into one class, to be known as white wheat. The designation of the subclass red walla was changed to western red.

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[1] Eight by Pacific coast board (seven wheat and one oats).

Combining the white wheats into one class served a very useful purpose, in view of the change effected in the method of doing export business in this wheat from the Pacific coast. The adoption and use of so-called Portland Chamber of Commerce type samples had long been a source of complaint from producers in the Northwest. It had been the practice of exporters to purchase wheat from producers on the basis of Federal grades and then export it on the basis of type samples. After meeting with interested parties it was concluded that the manner in which these type samples were being employed was not only uneconomic but in effect established a system of grades other than Federal grades and consequently was prohibited by law. Accordingly, the Secretary ordered that their use be discontinued on June 30, 1922. The change in the standards will be helpful to these exporters in that much wheat that would otherwise grade mixed will be given a straight class designation under the standards. Moreover, the use of the Federal grades by exporters as the basis of contract may be expected to reflect back to producers the benefits of market prices for grain of the different grades.

Of the outstanding difficulties encountered in inspection work mention may be made of the heat-damaged and weevily wheat in the Southwest and damage to corn east of the Mississippi River. These problems were approached with the cooperation of the inspectors and the trade, with the result that our statistical data compiled at general field headquarters show that notwithstanding the adverse conditions there resulted improved inspection accuracy for both wheat and corn over that which obtained during the previous year. Through a closely knit field organization checking intermarket movement of grain from primary markets through terminal markets in the Middle West, via the Lakes to the Atlantic seaboard and to Gulf ports for export, a high degree of uniformity was attained. For the most part this was accomplished by cooperation of licensed inspectors and inspection departments, although in some instances it was found necessary to take corrective measures. Charges were preferred against 21 inspectors for misgrading grain or otherwise violating the regulations. Formal hearings were accorded 18 inspectors and appropriate disciplinary action taken by way of suspension or revocation of licenses and placing the licensees on probation.

Findings of the Secretary were published in seven cases involving misrepresentations as to the grade of grain, fraudulent alteration of inspection certificates, and "plugging" cars with inferior grain. Other cases investigated were either pending at the close of the year or disposed of without formal action. Fifteen cases were recommended for prosecution under the criminal section of the law and are now receiving the consideration of the Solicitor of the Department.

### RESEARCH STUDIES OF THE HANDLING, MARKETING, AND STANDARDIZATION OF GRAIN.

The division leader was assisted in this work by E. G. Boerner.

During the year the tentative grades for grain sorghums were put in mimeographed form and distributed to the trade. These standards have been adopted by boards of trade and inspection departments in a number of States and are now in use in all of the important grain-sorghum markets. Further study has been given to the tentative grades for rye, which were established during the previous year, and some minor changes have been made. These grades are now being published. Investigations were carried on also covering rough rice, brown rice, flax, and barley looking toward the establishment of United States grades for these grains.

Investigation of the milling and baking qualities of wheat varieties was conducted for the purpose of securing information which will lead to the development and production of superior wheat. Milling and baking investigations of the various classes and grades of wheat marketed in commerce and special investigation covering the factors determining commercial grades were carried on in connection with suggested changes in the Federal wheat grades established by the department under the grain standards act.

Seed of an Asiatic grass (Adlay) grown in the Philippine Islands was experimented with from the standpoint of its bread-making qualities. Methods and equipment for milling this seed, as well as the milling and baking results from tests of various mixtures of flour from Adlay seed and wheat flour, were reported.

Two types of an improved grain-cleaning device designed for use on threshing outfits were developed and tested experimentally in the Pacific northwest and central northwest grain-producing areas last harvest. Both types gave very satisfactory results. The recleaners with improvements developed during the last harvest are being operated experimentally during this harvest in both the Pacific and central northwest. General use of the improved recleaners on threshing outfits will greatly benefit the producer and country shipper. It will enable the producer to put upon the market a higher grade and more valuable product and at the same time the country shipper will be saved transportation charges on trash.

Investigations of the bulk handling of grain in the Pacific coast producing section and at export points has been conducted in connection with the transition from sack to bulk handling of grain in that territory. As a result of these investigations it has been possible to assist producers and country dealers interested in handling grain by bulk, also State agencies and municipal authorities interested in port facilities for grain handling.

A number of bulletins were published (see list at end of this report) and manuscripts for other bulletins, covering United States grades for rye and grain sorghums, bulk handling of grain on farms, foreign material in spring wheat, and a revised handbook covering the official grain standards for wheat, shelled corn, and oats were prepared during the year and submitted to the printer.

## DIVISION OF CROP AND LIVE-STOCK ESTIMATES.

The work of the Division of Crop and Live Stock Estimates has been conducted under the supervision of L. M. Estabrook, associate chief of bureau, assisted by W. F. Callander and Nat C. Murray.

### CROP REPORTING BOARD.

The personnel of the Crop Reporting Board includes the associate chief of the bureau, as chairman, the chief statistician of the division, three statisticians from the Washington office, and two agricultural statisticians from the field, the last two named being changed each month.

### STATISTICAL WORK OF THE DIVISION.

The established lines of work in crop and live-stock estimating were continued during the year. These included, for the major crops, preliminary estimates at planting time of acreage under cultivation, followed by monthly reports during the growing season of crop conditions accompanied by forecasts of production based upon acreage and condition, and by estimates after harvest of yield per acre, total production, quality, and value. The stocks of different crops remaining on farms at various dates have been estimated. In addition, reports of condition of minor crops have been prepared monthly during the growing season. About sixty crops in all are covered in more or less detail. Prices received by producers at local markets and shipping points have been collected and published monthly, together with index figures showing the relation of current prices to those received at past dates and the purchasing power of farm products in terms of other products. Prices paid by farmers have also been collected and plans made for the systematic gathering of such data for the purpose of preparing index numbers.

Farm wages have heretofore been reported annually. Recently it was decided to make quarterly reports concerning wages.

Data have been collected and published concerning the total number of head of the different classes of live stock on farms on January 1, the number of stock hogs in September, the number of brood sows in April, and the condition and mortality of live stock in May. A monthly report relative to the change in numbers of live stock on farms has been made, based on reports from a list of approximately 15,000 farmers. This work has been going on for about three years.

A special inquiry was made in May concerning the number of sows farrowing during the first six months of 1921 and 1922, respectively, and the number which farrowed during the last six months of 1921, compared with the number of sows bred or intended to be bred to farrow during the last six months of 1922. The size of litters and the number of pigs saved were also ascertained.

Separate preliminary estimates were made during the past year for the first time of the acreage under cultivation June 1 of durum wheat, as distinguished from the hard spring-wheat varieties. This separation was made in the four leading States, namely, Minnesota, North Dakota, South Dakota, and Montana. The investigation was undertaken in response to frequent and repeated requests from those interested in the production, marketing, and milling of spring wheat.

### COMPARISON WITH THE UNITED STATES CENSUS.

During the winter the crop and live-stock estimates of this division were checked against the returns of the United States Census of 1919, which had become available in the autumn of 1921, and revisions of the estimates were made where found justified for the years 1919, 1920, and 1921. It was found that on the whole the estimates were in much closer accord with the census than was the case when revisions were made subsequent to previous decennial census reports. Certain seeming differences were found to be due largely to the differences in the forms used by the census and the Division of Crop and Live Stock Estimates or in the form of presentation of the data.

For instance, the census report for 1919 for corn showed a total of 87,771,600 acres, against an estimated total for the same year by this division of 100,072,000 acres. The census figures, however, included only corn grown for grain and harvested after ripening, while the estimate of the division included corn grown for all purposes. The census showed under another item about 14,500,000 acres of corn cut for forage. There was considerable duplication in this item of acreage reported under corn grown for grain. Under another head the census had an item of 4,000,000 acres of silage crops known to be mostly corn. Elsewhere it showed large acreages of corn grazed and hogged off. With these differences in presentation taken into consideration the estimates of the division and the census report are not far apart.

### CROP REPORTING LISTS.

The major and minor reporters' lists of the division comprise 193,000 names and require for their maintenance practically the entire time of 10 clerks. The following table shows the number of names on each list:

*Number of reporters on various lists.*

| List. | 1921 | List. | 1921 |
|---|---|---|---|
| Township | 25,798 | Special cotton | 6,321 |
| County | 2,720 | Honeybee | 3,839 |
| County aids (estimated) | 8,160 | Potato | 7,352 |
| Field aids | 27,558 | Maple sugar and sirup | 2,017 |
| Special price | 7,500 | Truck | 9,369 |
| Live stock | 14,514 | Canners' associations | 2,500 |
| Mill and elevator | 22,530 | | |
| Individual farm | 52,774 | Total | 192,952 |

In addition to these, the agricultural statisticians in most of the States maintain large special lists, so that the total number of reporters of the bureau is considerably in excess of 200,000.

During the year approximately 2,240,000 schedules of inquiry were sent out from the Washington office. In addition a large number of schedules were sent out from the field offices and returned direct to them. These would probably approximate the number sent out from Washington.

### FOREIGN CROP-REPORTING SYSTEM STUDIED.

In September a representative of the division, W. F. Callander, was sent to Europe to study the crop-reporting systems of the various countries. He visited practically all of the countries west of Russia and has submitted a detailed report of his findings. The systems used in the various countries vary widely, some of them being very complete, while others are very limited in their scope.

In May, N. C. Murray, chief statistician of the division, was sent to Rome as a delegate to the sixth general assembly of the International Institute of Agriculture. Of the 62 countries adhering to the institute, 51 had representatives at this assembly. The subjects submitted by the Government of the United States for consideration at the general assembly were as follows:

1. That English be made the official language of the institute as well as French in all its proceedings and publications, and that this proposal be placed

at the head of the program for early action by the general assembly, immediately after it is organized for business.

2. That the International Institute be instructed to urge upon the adhering governments the taking of decennial censuses of acreages in different crops and numbers of live stock.

3. That the International Institute be instructed to urge upon the adhering governments greater promptness in completing and transmitting crop reports and statistics to the institute, and that the statistical service of the institute be instructed to publish the reports as soon after the 10th day of each month as may be practicable, listing in the monthly publications of the institute the names of the countries which fail to send their reports to the institute in time for publication.

4. That the International Institute be instructed to urge upon the adhering governments improved methods of collecting statistics of crop and live-stock production, consumption, imports and exports, stocks, marketing prices, and economic factors affecting supply, demand, and prices.

5. That the International Institute be authorized to employ one or more statisticians to visit the statistical departments of the adhering governments, with a view to studying and reporting upon their statistical organizations, systems, and methods, and suggesting improvements therein, in order that agricultural statistics throughout the world may be dependable, timely, and comparable.

6. That the secretary general of the institute be instructed to prepare and submit to the commission on administration of the general assembly of the institute a statement showing, for each department of the institute, the names of its employees in service on May 1, 1922, their ages, their nationality, the length of time they have been in the service of the institute, their initial salaries, dates, and a statement of promotions, nature of their duties, and their education and experience.

7. That the secretary general of the institute also be instructed to submit to the commission on administration of the general assembly a statement showing the gold value of the contributions of each adhering government to the support of the institute for the calendar years 1921 and 1922.

All of these propositions were adopted with slight modifications.

### FIELD TRAVEL INCREASED.

The increased funds for travel available for the fiscal year 1922 relieved to a considerable extent the handicap under which the agricultural statisticians in the field had labored during the preceding two years and made it possible for them to again establish the personal contacts with field conditions. The funds available for the current fiscal year have been again increased, which should result in a further improvement in the work of the field representatives.

### SEMIMONTHLY CROP NOTES.

Through the medium of general reports on crop conditions given out semimonthly, an effort is made to meet a demand which exists for crop reports oftener than once a month. The distinction between these so-called "semimonthly crop notes" and the regular monthly crop reports is that while the latter reports are in actual figures of present conditions, the crop notes describe in general terms the significant changes taking place.

### INVESTIGATION OF STATISTICAL METHODS BY OUTSIDE EXPERTS.

During the year, at the invitation of the department, three of the leading statisticians of the United States—Carroll W. Doten, of the Massachusetts Institute of Technology and ex-president of the American Statistical Association; Willfred I. King, of the National Bureau of Economic Research, of New York City; and Warren M. Persons, of Harvard University—visited Washington and investigated the methods and work of the crop-reporting service, for the purpose of discovering any faults in the methods of procedure and suggesting possible improvements.

This committee made a detailed report, and while, in general, it recommended "that the methods of securing the data should remain substantially unchanged," it made certain suggestions for modifications in methods which have been found helpful, but the funds available for use in the division make it impossible to carry out all the suggestions offered.

The committee recognized that the really essential and most difficult problem is that of determining accurately the changes in acreage devoted to different crops and the number of live stock. Experiment had already been made in the making of personal field counts to determine acreage, with satisfactory results, and during the 1922 crop season the plan was made one of the regular modes of procedure in estimating acreage. The results indicate that in the Central, Eastern, and Southern States, with few exceptions, it will probably become an excellent check upon acreage changes.

Other checks upon acreage already in use were continued and developed during the season. These include (1) a study of acreage changes upon a large number of individual farms which report annually the acreage in each crop on their own farms for the current and previous year, (2) a study of the returns to assessing officers of acres planted to different crops, (3) records of commercial movements and receipts of agricultural products, and (4) special acreage questionnaires sent to the regular crop reporters of the division.

### COOPERATION IN CROP REPORTING.

With the exception of two States, the division now has cooperative arrangements with every State which maintains a regular crop-reporting service and publishes reports on crops. During the year just closed arrangements were completed with the New York Department of Agriculture for a joint service in New York and with the Minnesota Department of Agriculture for a joint service in that State. Cooperative agreements for this work are in effect in 28 States.

### ENLARGED LIVE-STOCK REPORTING WORK.

During the latter part of the year attention was given to the development of plans for an enlarged live-stock reporting service. Congress having granted an increase in the funds of the bureau for this purpose, beginning July 1, 1922. Believing that the best results could be secured by confining the proposed expansion of the live-stock work to certain specific lines, it has been decided to give special attention to developing a service for reporting marketable supplies and movements of meat animals, including cattle, sheep, and swine. Conferences were held in Chicago and Denver which were attended by live-stock producers and others and tentative plans of work drawn up.

## DIVISION OF INFORMATION.

The information work of the bureau was under the direction of W. A. Wheeler until February, 1922, when J. Clyde Marquis assumed responsibility for this work.

The information work of the bureau has been expanded and reorganized during the past year on account of the merging of the Bureau of Markets with the Bureau of Crop Estimates on July 1, 1921, and of the anticipated merging of the Bureau of Markets and Crop Estimates with the Office of Farm Management and Farm Economics on July 1, 1922. The information work of the bureau aims (1) to furnish farmers and others interested in agriculture specific information and suggestions in such form as to be readily available for practical use and application; (2) to keep before American farmers information which will furnish a definite economic background which will aid them in specific decisions, plans, and actions, and tend to relate them to general economic agricultural conditions and movements; (3) to acquaint the public at large with the intimate connection between the farmers' marketing problems and the economic problems of other groups.

This division is charged with the supervision of the issuance of all information relating to the activities of the bureau. In addition to the formulation of general policies covering the release of market news and other current reports, the division prepares the material for publication in the department publication Weather, Crops, and Markets, prepares press releases covering matters of immediate interest, and supervises the preparation of mimeographed reports containing information on foreign crops and markets, and of general marketing activities. This division also directs the work of preparing exhibits, motion pictures, etc., for the purpose of making graphic presentation of certain phases of the activities of the bureau. The work of editing all manuscripts prepared for publication is also carried on in this division. Aid is given to authors in planning publications and attention is given to the form in which material is presented as well as to the adequacy of the treatment of subject matter. A list of the publications of the bureau for the past year is appended to this report.

## WEATHER, CROPS, AND MARKETS.

In January, 1922, three periodicals were merged to form Weather, Crops, and Markets. These three publications were the Market Reporter, the Crop Reporter, and the National Weather and Crop Bulletin. This new combined periodical thus became a departmental rather than a bureau project. The material relating to crops and markets is prepared in this bureau, and this division acts for the Division of Publications in caring for the make-up and proof work for the entire periodical.

Weather, Crops, and Markets contains information prepared by the Weather Bureau and also statistical and other information prepared in this bureau, covering data secured by the Division of Crop Estimates, and by the Market News and other services of the bureau. This information is similar to that formerly carried in the three separate publications. In addition, effort is made to include articles of definite interpretative and economic value.

## PRESS RELEASES AND SPECIAL ARTICLES.

The results of the regular work of the bureau, and significant developments of interest and value to the public, have been placed before the general public and before specific groups by means of general press items released through the Press Service of the department and by special articles contributed to selected and representative magazines. The press has realized as never before the importance of the bureau's work in agricultural economics and has devoted considerable space to the presentation of the bureau's findings. More than 250 news stories and items of an economic character, ranging from 300 to 1,500 words each, have been prepared for this purpose. Effort has been made also to place brief informative special articles in journals reaching readers other than agricultural, with a view to interpreting the farmer and his problems to the reading public and acquainting that public with progress made.

### RADIO NEWS SERVICE.

Rapid progress has been made in developing the Radio Market News Service, and the reception of "up-to-the-minute" agricultural reports either by radio telegraph or radio telephone practically everywhere in the eastern two-thirds of the United States has been made possible. At designated hours each day the bureau furnishes current market news to radio stations at the Post Office Department at Washington; Omaha and North Platte, Nebr.; Rock Springs, Wyo.; Elko and Reno, Nev., for broadcasting; the Arlington and Great Lakes wireless stations of the Navy Department, and to 53 stations operated by State agricultural colleges and bureaus of markets, newspapers, and other broadcasting agencies. Another important development of the work has been the broadcasting from these stations of estimates of crop conditions, acreages, and yields as issued by the crop reporting board.

This entire work has been conducted at comparatively slight expense to the department, inasmuch as it has involved merely a fuller utilization of existing agencies for collecting and disseminating market news. The reports are made up from the market news on live stock and meats; fruits and vegetables; grain, hay, feed, and seeds; dairy products; and cotton, already passing over the leased telegraph-wire system, and is distributed by radio without expense to the department by various Government and private broadcasting stations.

### MARKETGRAM SERVICE.

The Marketgram Service consists of the preparation and release of a very condensed summary of the principal information secured by the Market News Service, relative to the supply, demand, prices, movement, etc., of agricultural products. This service is now extended to nearly 2,000 country newspapers, agricultural publications, banks, and other agencies that can give wide publicity to market news. The circulation of these mediums is conservatively estimated at five million readers.

## COSTS-OF-MARKETING DIVISION.

This work was directed by Dr. H. E. Erdman. The division leader was assisted by A. V. Swarthout.

Particular attention has been devoted during the past year to the cost of marketing live stock in the Corn Belt States. This study has now been extended to include the southern territory and the range States. A large volume of information has been secured which will prove very valuable in answering the many inquiries for information along this line. In carrying out this work it is necessary to observe a wide range of related factors and an opportunity is afforded to collect additional information which is useful for a number of purposes. The information has in all cases been secured from accounting records.

Data were obtained from 219 organizations which ship live stock on a cooperative basis, 37 local buyers, and 27 producers who ship their own stock independently. These organizations are located in the States of Wisconsin, Minnesota, South Dakota, Iowa, Nebraska, Kansas, Missouri, Illinois, Indiana, Ohio, and Kentucky.

Tabulation of this material has proceeded to the point where it is possible to state that the cooperative agencies from which information was secured shipped more than $22,000,000 worth of stock during 1921. This is divided among species as follows:

| | Number. | Sales value. |
|---|---|---|
| Hogs | 941,752 | $18,087,586 |
| Cattle | 55,274 | 2,898,770 |
| Calves | 60,335 | 810,036 |
| Sheep | 75,636 | 479,403 |
| Total | 1,132,997 | 22,296,795 |

In studying the detail of these figures it is interesting to note that 68 per cent of the hogs were shipped in straight carloads, 35 per cent of the cattle, 9 per cent of the calves, and 50 per cent of the sheep. These figures reflect the type of live-stock raising which obtains in the areas under observation.

A very large volume of data has been gathered during the progress of this study. Out of these figures will be compiled information which has not hitherto been available with regard to the following subjects: Conditions under which shrinkage, crippling, and killing in transit and in terminal markets occur most frequently; costs of transportation to selling market; of selling through livestock commission men; of selling direct to contractors; of handling through the local shipping agency; and much other valuable statistical information regarding the marketing practices in this industry.

When sufficient progress has been made in the compilation and tabulation of these data, it is planned to publish a series of bulletins, each dealing with a specific phase of the marketing of live stock through the agencies studied. In each case it is felt that information is now available through which a comparison can be made between the various services and their respective costs for a number of methods of marketing live stock. A preliminary report of this work will be released in the near future.

These studies have been carried on from the viewpoint of being helpful to the individual in making his business more efficient; of furnishing standards whereby the relative efficiency of two or more marketing agencies can be judged; of establishing the necessary costs in each step in the marketing of a particular product; and of enabling the dealing public to see more clearly the part that the cost of service plays in the establishment of consumers' prices.

## DIVISION OF STATISTICAL AND HISTORICAL RESEARCH.

The major part of the work of this division was under the direction of Frank Andrews until April 4, 1922, when the division was reorganized and Dr. O. C. Stine was placed actively in charge.

Following the consolidation of the Bureau of Markets with the Bureau of Crop Estimates, and in anticipation of the further consolidation of this bureau with the Office of Farm Management and Farm Economics, careful consideration was given to the organization of a division which would include the statistical and historical research work of the entire bureau.

This division as reorganized maintains files of all matter of permanent statistical value collected by the various divisions of the bureau. These records include such data as statistics of the acreage, yield, and production of crops, number of live stock on farms, farm prices of products, etc., formerly handled by the Division of Crop Records in the Bureau of Crop Estimates; statistics and other historical data relative to the development of agriculture and the economics of farming secured by the Office of Farm Management and Farm Economics; records of receipts, supplies, movements, and market prices of farm products, including reports of cold-storage holdings and similar data collected by the various divisions of the former Bureau of Markets.

An enormous mass of information relating to agricultural production and distribution is collected and made public through the various services of this bureau. These data are of current value and have served chiefly as a guide to orderly marketing. The files of this material, however, now cover long periods of years, and these figures, when tabulated and summarized, furnish bases for economic studies covering shifts in agricultural enterprises, trends of production and prices, and analyses of the fundamental factors affecting agricultural conditions.

### FOREIGN COMPETITION AND DEMAND.

This division maintains representatives in foreign countries who collect information relating to foreign competition and demand, maintain contacts with agricultural agencies in foreign countries, and arrange for the securing of data relating to agricultural production and conditions in these countries.

Particular attention is being given to the utilization of material now at hand, and to making arrangements to secure other information which will make it possible to compile and publish complete summaries covering the world supply of, and the demand for, agricultural products. Such summaries will furnish an accurate guide to American agricultural production.

During the past year the division has maintained representatives in Argentina, London, England, and in the Balkan countries who have collected information relative to the agricultural competition of foreign countries with the United States, and the demand for American agricultural products in foreign countries.

During a part of the year, a man has been stationed in England to study the market for our pork and pork products. Recently he has gone to Germany to collect information relative to the demand for American pork and pork products in that country. Another man has been maintained throughout the year in London. London is a very important center for the interchange of information from all parts of the world. It is comparatively easy to keep in touch with the agricultural situation in all parts of the British Empire by keeping in close touch with the British capital. The man located in London is also in a position to form desirable contacts with officials and others in European countries.

In addition to maintaining these representatives in foreign countries, two men were sent to Europe to make an economic survey of agricultural reconstruction in Europe, and to arrange for the interchange of information as to the condition and production of crops in these countries.

A beginning has been made toward establishing a world crop-reporting service. Arrangements have been made with Canada, India, and Norway for direct reporting of crop conditions and estimates of production by cable to the United States. The International Institute of Agriculture at Rome also cables estimates of production of the principal crops in which this country is interested. The Department of State, through consular officers, has rendered valuable aid in collecting information as to stocks on hand, conditions, and production of crops in several countries. The Department of Commerce also has given aid in collecting information as to crop conditions and economic conditions which influence the markets for agricultural products by furnishing reports of commercial attachés.

The United States was represented by six delegates at the sixth general assembly of the International Institute at Rome. At this assembly it was decided that the institute should expand its program to include the collection of statistics on other important crops and live stock. It was also decided that the institute should make more extensive use of cables and telegrams to collect and disseminate information as to the condition and production of crops. The carrying out of this program will greatly facilitate the development of a world agricultural production and market-reporting service for the United States. (See Division of Crop Estimates.)

A large part of the statistical section published in the department Yearbook was prepared in this division. This section includes tables covering production and international trade in specified agricultural products of all countries for which statistics were available; tables of quantity and value of agricultural products imported into and exported from the United States for the three years ending December 31, 1920; and tables showing high, low, and average wholesale prices of various agricultural commodities at 23 markets. Numerous statistical statements and summaries were prepared for publication during the year.

Statistical studies have been made covering many phases of the work of the bureau. A mimeographed bulletin which contains summaries of the crop and market information secured from foreign countries has been issued weekly, and a Handbook of Foreign Agricultural Statistics has been prepared and published. In addition, information has been prepared for publication in Weather, Crops, and Markets.

## DIVISION OF COOPERATIVE RELATIONS.

This division has been under the direction of L. S. Tenny, assistant chief of bureau, and includes the following activities:

Research studies relating to cooperative purchasing and marketing.
Cooperation with the States in marketing work.

### RESEARCH STUDIES RELATING TO COOPERATIVE PURCHASING AND MARKETING.

The division leader has been assisted in this work by R. H. Elsworth, A. W. McKay, and L. S. Hulbert. This project conducted research and extension work in 19 States during the past year. The studies made may be divided into three classes: Those relating to (1) economics of cooperation, (2) legal aspects of cooperation, (3) history and statistics of cooperation.

Among the studies conducted was one which included a comprehensive survey of the possibilities of the cooperative marketing of Vermont maple-sap products. The material collected in the producing sections and in the central markets where maple products are sold was worked into a manuscript which the agricultural experiment station of the University of Vermont is preparing to issue as a bulletin.

One representative of the bureau stationed at Copenhagen, Denmark, made a careful study of the cooperative features of European agriculture, particularly in the Scandinavian and north-central European countries. A large amount of detailed historical and statistical information was collected and is being compiled for future use.

In cooperation with the State Agricultural College of Michigan a detailed examination was made of the history and business methods of larger cooperative associations, such as the Michigan Potato Growers' Exchange, Michigan Elevator Exchange, Michigan Live Stock Exchange, Michigan Fruit Growers (Inc.), Michigan Milk Producers' Association, and Michigan State Farm Bureau. The data collected will be used in a bulletin to be issued by the State Agricultural College.

A study of cooperative stores in New York State was begun in cooperation with the New York State College of Agriculture. This study will extend over several years in order that the data collected may cover periods of different degrees of prosperity.

Preliminary surveys were made relative to the cooperative marketing of milk in New York, cooperative marketing of peanuts in Virginia, cooperative marketing of potatoes in South Carolina, and agricultural cooperation in New England.

Exhaustive studies of the legal aspects of cooperation have been conducted throughout the year. The conclusions reached have been worked into a bulletin which is now in press. During the year 20 short reviews of court decisions of importance to those interested in cooperative activity were prepared and released through official channels.

Following the approval by the President of the Capper-Volstead Act, February 18, a statement relative to the act was prepared for the information of those who might be interested in the scope of this legislation. Copies of the statement have been supplied to several thousand associations, whose officers expressed a desire for information regarding the significance of the act.

A suggested form of by-laws for a cooperative nonprofit marketing association and a suggested form of crop contract for farmers' cooperative marketing associations were worked out.

In order to collect a sufficient amount of material to permit of comprehensive statistical studies a nation-wide survey of agricultural associations was undertaken. Names and addresses of farmers' cooperative associations were obtained from local crop reporters in the 48 States, State marketing officials, farm bureau officers, agricultural college officials, and others.

In addition to the nation-wide survey of all cooperative associations, special efforts are being made to collect all available printed material regarding 100 outstanding organizations—organizations which, because of the volume of business they handle or because of unusual methods for solving difficult problems, are of special interest.

## COOPERATION WITH THE STATES IN MARKETING WORK.

The division leader was assisted in this work by G. O. Gatlin. During the past fiscal year this bureau cooperated with 33 States in the conduct of marketing work. These States were California, Colorado, Delaware, Georgia, Idaho, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Utah, Vermont, Virginia, Washington, and Wisconsin.

In 18 States cooperative arrangements were made with State bureaus of markets and departments of agriculture; in 24 States with experiment stations, extension divisions, and departments of State colleges of agriculture; and in 5 States with other educational institutions or farmers' organizations.

The plan under which work is conducted has been gradually changed. Cooperation in the joint employment of agents to conduct general marketing work in the States is being superseded by assigning bureau specialists to the States for a definite period of time to aid the State marketing specialists in specific problems.

The amount of work conducted in cooperation with State agencies during the past 12 months has exceeded that of any year in the bureau's history. The Division of Cooperative Relations has devoted time to reorganizing its work with State agencies, promoting work on a cooperative basis, establishing proper contacts, and in working out plans, agreements, and projects. The division leader and the two assistants engaged in this work traveled in practically every State in connection with administrative work and for the purpose of assisting State agencies in determining their problems and in planning their work.

This division works in cooperation with the commodity divisions of the bureau, rendering assistance in carrying out studies bearing upon the problems of the various divisions.

Research work covering the costs of marketing, methods of marketing, and cooperative marketing is conducted cooperatively with State agencies and with other divisions of this bureau. Assistance has been rendered in California, Georgia, and a number of other States in perfecting existing standards for fruits and vegetables and in formulating grades for products which have not yet been standardized. In several States assistance has been given in developing a food-products inspection service and in coordinating the work with that of the Federal bureau at receiving points. Assistance has been given to growers and shippers in several States in the marketing of wool. Educational and demonstrational work has been carried on in many places for the purpose of furnishing growers and shippers with information leading to better handling, packing, grading, loading, and shipping of their products. Local marketing problems have been studied in a number of States. For example, a study has been made of the marketing of Georgia sweet potatoes; studies have been made in the central northwest of the problems of local potato-shipping associations; in Oklahoma a series of demonstrations in grading and marketing grain have been conducted; a study has been made in Vermont covering the marketing of maple-sap products.

## ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT.

The administration of the United States warehouse act has been directed by H. S. Yohe.

During the past year unusual interest was shown in the Federal warehouse act by warehousemen operating on a large scale. This is especially true with regard to cotton warehouses, both in producing sections and at seaports.

A marked interest developed among grain warehousemen in sections in which no interest was shown prior to this year. In the Pacific Northwest one warehouseman, operating a chain of 15 elevators, another operating 68, and still another operating 112, obtained licenses under the Federal act. In this same section a number of warehousemen operating one or two houses also became licensed. There was also a substantial increase in the number of licensed grain warehouses in Colorado.

Factors which have contributed largely to the substantial progress made during this year are: (1) The more general appreciation on the part of bankers of the value of warehouse receipts issued under the act for collateral purposes, (2) the insistence on the part of some of the farmers' cooperative associations that their products should be stored only with warehousemen who were Federally licensed, and (3) the recognition accorded the Federally licensed warehouse receipt by the War Finance Corporation.

The purpose of the warehouse act is to provide a credit instrument for the farmer, so as to enable him to market his products in orderly fashion. That the act can accomplish this purpose has been amply demonstrated during the past year. Farmers' associations, as well as individual farmers throughout the country, have secured credit on favorable terms on warehouse receipts issued by the warehousemen licensed under the act.

The high opinion of the War Finance Corporation of receipts issued under the Federal act is shown by the fact that at no time during its operation has it refused an application for a loan which was to be supported by such receipts as collateral.

The following table shows the approximate number and combined capacity of warehouses licensed July 1, 1921, and on July 1, 1922:

| Type of warehouse. | July 1, 1921. | | July 1, 1922. | |
|---|---|---|---|---|
| | Number. | Capacity. | Number. | Capacity. |
| Cotton.......bales.. | 238 | 430,000 | 268 | 1,210,000 |
| Grain.......bushels.. | 56 | 2,110,000 | 263 | 14,441,000 |
| Wool.......pounds.. | 5 | 24,375,000 | 18 | 27,500,000 |
| Tobacco.......do.... | ........ | ........ | 14 | 68,395,000 |

## COMPLETION OF THE WORK OF THE DOMESTIC WOOL SECTION.

This work was directed by Wells A. Sherman assisted by W. L. Evans.

During the fiscal year 1922 field and office audits of the wool business of dealers handling the 1918 clip resulted in increasing the amount of excess profits due the Government to the extent of $205,941.53, making the total ascertained excess profits on 1918 wool $1,434,823.18. During the year $49,478.13 was collected from wool dealers and $91,931.92 was distributed to woolgrowers. During this period 372 additional reports were obtained from country dealers, the audit of which showed 73 additional country dealers as having made excess profits. Payments were completed in 74 cases, making the total number of cases closed 980, with 73 cases still awaiting settlement..

The total excess profits collected to date amount to $621.664.65, of which $315,159.38 has been distributed to growers. Of the balance on hand, amounting to $306.505.27, it is estimated that at least $117,000 will remain in the United States Treasury as undistributable. There are 73 cases awaiting settlement, involving $813,158.53, of which 47 cases, amounting to $626,693.22, are in the hands of the solicitor for collection through legal proceedings.

During the year four cases have been argued on demurrer, all of which have been decided in favor of the Government. It is expected that approximately 10 cases will be reached for hearing or trial in the fall of 1922.

## OPERATION OF CENTER MARKET, WASHINGTON, D. C.

The operation of Center Market is carried on under the direction of C. W. Kitchen.

Pursuant to an act of Congress approved March 4, 1921, the operation of Center Market was undertaken by this department on April 1, 1922. On March 31, 1922, the Appraisal Commission appointed by the President under the act above mentioned filed its award in the amount of $960,250, covering the purchase of the building and improvements at Center Market, which had been made at the expense of the Washington Market Co. The value of the land was not included in this appraisal, as title to the land has always vested in the Government. Upon the date of signing the award 75 per cent was paid to the Washington Market Co. and 25 per cent held by the Government pending settlement of an appeal which was immediately noted by the company.

Prior to the filing of the award by the Appraisal Commission preliminary work was necessary in order that the transfer might be made with a minimum of confusion. The transfer of a complicated business of this character presented many problems, and preparation for handling numerous details was necessary. Rules and regulations governing the operation and management of the market and the cold-storage plant were prepared and promulgated. All of the personnel of the Washington Market Co., except the officers of the company and four laborers, were retained by this bureau. This arrangement provided for the uninterrupted operation of the plant and avoided the serious confusion which would inevitably have arisen had the department been required to take over the property with an entirely new personnel. Fortunately, no important details were overlooked and the transfer was accomplished without interruption to business or inconvenience to tenants or to the public.

One of the most complicated problems encountered was the liquidation of the cold-storage accounts. When the transfer took place the cold-storage warehouse was nearly filled with perishable products. These goods had been accepted for storage by the Washington Market Co., and, consequently, the company had a lien upon all storage charges accrued to the date of transfer. The calculation and division of storage charges on several hundred accounts presented a difficult and important task which had to be done in connection with the uninterrupted conduct of current business under governmental procedure and methods. The liquidation of these accounts was not completed by the end of the fiscal year, but was well in hand and will shortly be entirely consummated.

Center Market represents a complex business organization. Retail market stands are leased to 176 tenants and curb and other spaces are provided for the use of approximately 200 farmers and truckers. Four large wholesale houses dealing in meats and provisions are listed among the tenants. In addition there is a large auditorium, a bowling alley, a billiard parlor, and a resturant.

One of the most prominent and complicated phases of the work is the operation of the cold-storage warehouse. There are approximately 500,000 cubic feet of space available for the use of tenants and others who may have need for storage facilities. While the Center Market plant does not possess some important advantages of the most modern cold-storage warehouses, its location and consequent convenience to dealers in the market district has enabled the department to retain the majority of the accounts formerly handled there. Since this plant must of necessity be operated on a competitive basis, adjustments in rates and forms of service must be made from time to time as demanded by business conditions.

Since assuming control of Center Market the department has taken vigorous measures to improve sanitary conditions. The meat stands are now under the supervision of a meat inspector, who not only requires that pure and wholesome meat be sold but that all utensils and equipment be kept thoroughly clean. In this connection equipment has been installed for furnishing hot water to tenants for cleaning purposes. Measures have been taken for the purpose of making the market more convenient and attractive to the public.

A vast amount of repair and improvement was necessary in order to place Center Market on a par with the modern public retail markets in some cities. During the three months of the past year in which the market was operated by the department, the interior of the auditorium and the market were painted and extensive repairs were made which have materially improved the appearance of the market. The insulation of part of the cold-storage rooms was renewed and other improvements made. All of the spare time of the force of the mechanical department was used in making minor repairs too numerous to mention.

The total receipts for the three months' operation of Center Market in the fiscal year 1922 amounted to $57,400.20 and the expenditures to $53,376.37. In these expenditures is included about $10,000 for repairs in the nature of permanent improvements. All receipts are turned into the Treasury as miscellaneous receipts and all expenditures are paid from an annual appropriation.

The control of Center Market furnishes an excellent opportunity for certain much needed research work, and plans are being made for the conduct of studies of the methods used in public-market operation and management in municipalities and of the development of modern sanitary market equipment. The actual operation of the market is being kept on a commercial basis and the methods employed in its management are those used by the most up-to-date commercial enterprises.

The efforts of the department have been met by a splendid spirit of cooperation, both on the part of former employees of the Washington Market Co. who have been retained in the service, many of whom have willingly worked overtime in an effort to prevent congestion and inconvenience to tenants and patrons of the market, and on the part of stand holders and other tenants who have cheerfully complied with the regulations of the department and have cooperated in an effort to improve the quality of the service rendered to the public.

## PUBLICATIONS ISSUED DURING THE FISCAL YEAR 1922.

### DEPARTMENT BULLETINS.

No. 948. Composition of Cotton Seed. 1921.

No. 977. Marketing Hay at Country Points. 1921.

No. 978. Weighing of Market Hay. 1921.

No. 979. Marketing Hay Through Terminal Markets. 1921.

No. 980. Inspection and Grading of Hay. 1921.

No. 982. Market Statistics. 1921.

No. 985. A System of Accounting for Cotton Ginneries. 1921.

No. 987. Handbook of Foreign Agricultural Statistics. 1921.

No. 990. Preliminary Manufacturing Tests of the Official Cotton Standards of the United States for Color for Upland Tinged and Stained Cottons. 1921.

No. 999. Prices of Farm Products in United States. 1921.

No. 1002. Open Types of Public Markets. 1921.

No. 1006. Accounting Records for Sampling Apples by Weight. 1921.

No. 1013. The Influence of Relative Humidity and Moisture Content of Wheat on Milling Yields and Moisture Content of Flour. 1921.

No. 1019. Marketing Broom Corn. 1921.

No. 1030. Meade Cotton; an Upland Long-Staple Variety Replacing the Sea Island. (In cooperation with the Bureau of Plant Industry.) 1922.

No. 1044. Self-service in the Retailing of Food Products. 1922.

No. 1056. Marketing Cotton Seed for Planting Purposes. 1922.

No. 1065. The Test Weight of Grain; A Simple Method of Determining Accuracy of the Testing Apparatus. 1922.

### FARMERS' BULLETINS.

No. 1055. Country Hides and Skins—Skinning, Curing, and Marketing. 1919. (In cooperation with the Bureau of Chemistry and the Bureau of Animal Industry.)

No. 1204. Northwestern Apple Packing Houses. 1921.

No. 1232. Seed Marketing Hints for the Farmer. 1921.

No. 1266. Preparation of Peaches for Market. 1922.

### YEARBOOK SEPARATES.

No. 834. Know Your Markets. 1920 Yearbook.

No. 850. The March of Standardization. 1920 Yearbook.

No. 860. The Farmers' Interest in Foreign Markets. 1920 Yearbook.

### DEPARTMENT CIRCULARS.

No. 183. Seedtime and Harvest.

### OFFICE OF THE SECRETARY CIRCULARS.

No. 155. Rules and Regulations of the Secretary of Agriculture Under the Food Products Inspection Law. 1921.

### SERVICE AND REGULATORY ANNOUNCEMENTS (MARKETS).

Index to S. R. A. from 1 to 50.

No. 69. Suggestion for an Ordinance to Establish, Locate, Regulate, and Maintain a Public Farmers' Market and for Other Purposes. 1921.

No. 70. State Bureaus of Markets, including Divisions and Other Agencies doing Marketing Work. 1921.

## PUBLICATIONS IN PRESS ON JUNE 30, 1922, WITH APPROXIMATE TITLES.

Bulk Handling of Grain on the Farm.

Foreign Material in Spring Wheat.

Crop and Live Stock Estimates, 1910–1921. (Handbook.)

Handbook for the Inspection of Whole Milk American Cheese.

Legal Phases of Cooperative Associations.

Organization and Management of Cooperative Live Stock Shipping Associations.

Regulations for Cotton Warehouses. Revised. Off. of Sec. Cir.

United States Grades for Potatoes. Dept. Cir. 238.

Marketing of Mill Feeds.

Handbook of Official Grain Standards for Wheat, Shelled Corn, and Oats.

Soft Pork: Slaughter and Curing Tests to Determine Market Value.

Live Stock Industry in South America.

Business Methods for Marketing Hay.

Defects in the Quality of Butter.

Sales Methods and Policies of a Growers' National Marketing Agency.

Producers' Cooperative Milk-Distributing Plants.

Imports and Exports of Agricultural Products.

Preparation of Tomatoes for Market.

Service and Regulatory Announcement (Markets) No. 71; Complete Lists of Warehousemen.

Farm and Terminal Market Prices. Wheat, Corn, and Oats, Crop Movement Year 1920–21.

# REPORT OF CHIEF, OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS.

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UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS,
*Washington, D. C., July 17, 1922.*

SIR: I am submitting herewith the annual report of the Office of Farm Management and Farm Economics for the fiscal year ended June 30, 1922.

Respectfully,

H. C. TAYLOR,
*Chief.*

Hon. H. C. WALLACE,
*Secretary of Agriculture.*

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As this is the final report of the Office of Farm Management and Farm Economics as a departmental unit, it seems desirable to supplement the current report with a brief recapitulation of the history and achievements of the office from the time of its organization to that of its merger with the Bureau of Markets and Crop Estimates to form the Bureau of Agricultural Economics, as provided by Congress in the appropriation bill for the Department of Agriculture for the fiscal year 1923. It is now nearly 20 years since the work of the office was inaugurated in the Bureau of Plant Industry, and in that time these activities have come to assume an important place in the field of farm economics, particularly with reference to studies in farm organization and in the analysis of the farm business.

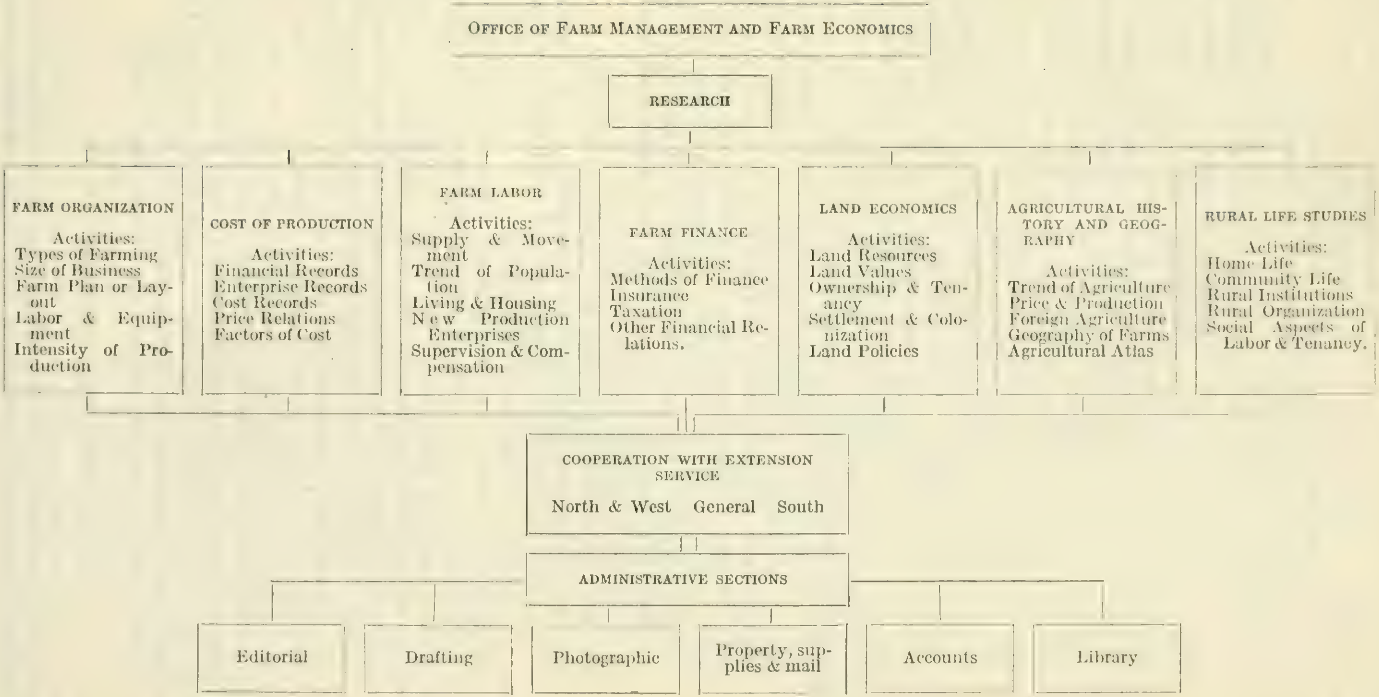
## BRIEF HISTORY OF OFFICE.

The Office of Farm Management and Farm Economics represents the outgrowth of work started in the Bureau of Plant Industry in 1904, when investigations of farm management and farm practice were set on foot by that bureau. For several years this work was conducted by the Division of Grass and Forage Crop Investigations, under the direction of Dr. W. J. Spillman, in 1904 as agrostologist, in 1905 as agriculturist, and from 1906 to 1916 as agriculturist in charge of farm management. In the agricultural appropriation act for the fiscal year ended June 30, 1907, there appeared for the first time the phraseology "To investigate and encourage the adoption of improved methods of farm management and farm practice," under which appropriations for this work have been made from that time forward.

On July 1, 1915, the Office of Farm Management was transferred from the Bureau of Plant Industry to the Office of the Secretary. At the same time certain branches of work that had been carried on by the office, such as investigations in farm architecture and in farm home management, were transferred to other units of the department, and the title of Doctor Spillman as chief of the office was changed from agriculturist in charge to Chief of Farm Management. A year later this title was further changed to Chief of Office.

In 1918, with the resignation of Doctor Spillman, Secretary Houston appointed a committee of nationally known workers in the field of farm economics to draw up a plan for the reorganization of the office. In the meantime, Prof. R. L. Adams, of the University of California, was temporarily made acting chief. The report of this committee (see Circular 132, Office of the Secretary) submitted to the Secretary on February 26, 1919, was adopted, and on March 8, 1919, Dr. H. C. Taylor, of the University of Wisconsin, was appointed chief.

Under Doctor Taylor the work of reorganization was carried out along the lines laid down by the committee on reorganization. Beginning July 1, 1919, the name of the office was changed to Office of Farm Management and Farm Economics, and on July 1, 1920, it became an independent office. On July 1, 1921, Doctor Taylor was appointed Chief of the Bureau of Markets and Crop Estimates and G. W. Forster, assistant chief, was made acting chief, pending the contemplated merger of the office with Markets and Crop Estimates, which was finally authorized by the act making appropriations for the fiscal year beginning July 1, 1922. The organization of the office as of June 30, 1922, is shown in the accompanying chart.


OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS
RESEARCH
FARM ORGANIZATION
Activities:
Types of Farming
Size of Business
Farm Plan or Layout
Labor & Equipment
Intensity of Production
COST OF PRODUCTION
Activities:
Financial Records
Enterprise Records
Cost Records
Price Relations
Factors of Cost
FARM LABOR
Activities:
Supply & Movement
Trend of Population
Living & Housing
New Production Enterprises
Supervision & Compensation
FARM FINANCE
Activities:
Methods of Finance
Insurance
Taxation
Other Financial Relations.
LAND ECONOMICS
Activities:
Land Resources
Land Values
Ownership & Tenancy
Settlement & Colonization
Land Policies
AGRICULTURAL HISTORY AND GEOGRAPHY
Activities:
Trend of Agriculture
Price & Production
Foreign Agriculture
Geography of Farms
Agricultural Atlas
RURAL LIFE STUDIES
Activities:
Home Life
Community Life
Rural Institutions
Rural Organization
Social Aspects of Labor & Tenancy.
COOPERATION WITH EXTENSION SERVICE
North & West
General
South
ADMINISTRATIVE SECTIONS
Editorial
Drafting
Photographic
Property, supplies & mail
Accounts
Library

*Achievements.*—Prior to the reorganization of 1919, perhaps the most important work done by the office was in the field of farm management survey. Among the significant surveys conducted by the office up to that time may be mentioned the following:

Three representative areas in Indiana, Illinois, and Iowa (Dept. Bul. 41); Utah Lake Valley (Dept. Bul. 117); Chester County, Pa. (Dept. Bul. 341); The Blue Grass Region (Dept. Bul. 482); Sumter County, Ga., first survey (Dept. Bul. 492); Monett, Mo. (Dept. Bul. 633); Brooks County, Ga. (Dept. Bul. 648); Anderson County, S. C. (Dept. Bul. 651); Irrigated Valleys of Arizona (Dept. Bul. 654); Ellis County, Tex. (Dept. Bul. 659); Lenawee County, Mich., Willamette Valley, Wash. (Dept. Bul. 705); Southwestern Kentucky (Dept. Bul. 713); Washington County, Ohio, continuing survey (Dept. Bul. 716); Clinton County, Ind.; Dane County, Wis.

Since the reorganization of 1919, work has been continued on the surveys in Washington County, Ohio; Clinton County, Ind., and Dane County, Wis. (Dept. Bul. 920); a survey in northwestern Pennsylvania has been completed (Dept. Bul. 852) and another in the Ozark region (Dept. Bul. 941), and preliminary reports have been issued on surveys in New Hampshire, Florida, Virginia, and Maryland. The office now has a total of 32,000 survey records on file.

Among miscellaneous studies conducted by the office prior to 1919 may be mentioned those of machinery cost of farm operations; carrying capacity of ranges; duty of implements, workmen, and crews; seasonal distribution of farm labor; haymaking crews; methods and labor costs; the experience of farmers with tractors; clearing land; operation of various farm implements; and farm practice in various parts of the country. Extended investigations were made in the cost of producing apples and sugar beets, and some cost work was done on cotton, milk, wheat, and a few other products.

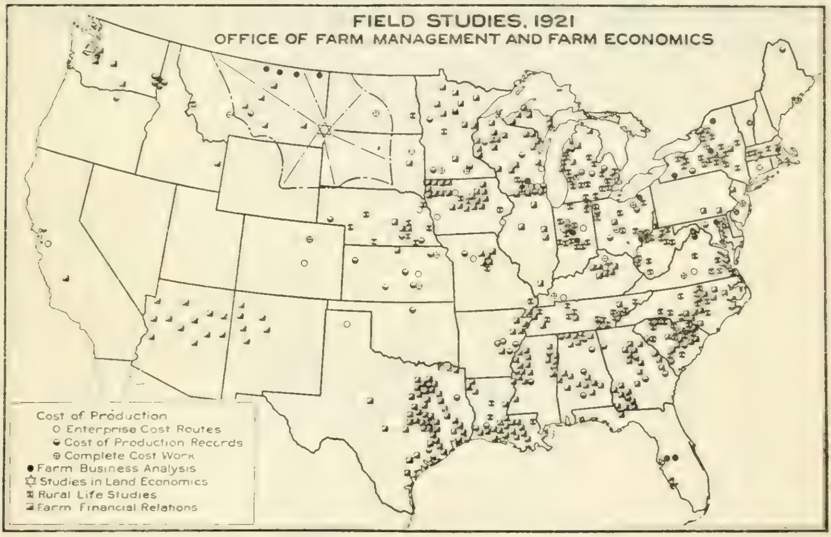
An important feature of the work of the office since 1913 has been in the field of agricultural history and geography. A Geography of World Agriculture has been prepared and published, and several sections of an Atlas of American Agriculture.

Since 1919 special stress has been laid on work in cost of production, land economics, rural sociology, the problems of farm financing and insurance, and the analysis of the farm business. A long-time study of the cost of beef production has been inaugurated, and work has been done on the cost of producing wheat, potatoes, cotton, rice, apples, citrus fruit, and milk. Special attention has been devoted to determining the basic factors of production, such as hours of labor and quantities of seed and other materials required. A study has been made of the land boom in Iowa (Dept. Bul. 874); of cost and utilization of power on farms where tractors are owned (Dept. Bul. 997); of short term bank loans to farmers (Dept. Bul. 1048); of the influence of a single farm community (Dept. Bul. 984); of the use of the land bank system in buying farms (Dept. Bul. 968); and of harvest labor problems in the wheat belt (Dept. Bul. 1020).

## WORK FOR FISCAL YEAR 1921–22.

During the fiscal year just past substantial progress has been made in the study of the cost of producing beef cattle, wheat, cotton, rice, potatoes, and hogs. Important studies in farm tenure have been carried forward. Work in farm financial relations has been concerned with farm loans, credit associations, crop insurance, and the organization of rural telephone systems. A unique study of the national influence of a single farm community has been brought to a close. More than a thousand farm business analysis records have been added to the data on farm organizations on file, and work has been pushed on the analysis and interpretation of the returns of the 1920 census with reference to agriculture.

*Cost of production.*—Continuing work on the cost of producing beef cattle in the Corn Belt, studies have been carried on in Nebraska, Iowa, Illinois, Indiana, and Missouri, in cooperation with the State colleges of agriculture in those States. During the summer of 1921 cattle feeding enterprise records were obtained covering 14,982 head of cattle, together with complete farm business analysis records for 300 of the farms concerned. In the fall of 1921 five detailed cost accounting routes, each of about 35 farms, were organized in each of the cooperating States. Work of tabulating the returns from these surveys is now well along toward completion. Preliminary reports of results have been issued covering the work in each State.



Field work on the cost of producing beef on ranges was begun in January, 1922. Work on the cost of hog production, begun in 1920, has been carried forward, and a study of the cost of producing dairy products has been started in cooperation with the College of Agriculture of the University of Wisconsin. In this latter study 277 enterprise and farm business analysis records have been obtained. In addition detailed cost records are being kept on 60 dairy farms.

Tabulation of wheat-cost records from 464 farms in the central wheat belt has been completed, a preliminary report issued, and a final report prepared for publication. The second year of a study of the cost of wheat production in the Palouse region has been completed and the first year's work done in a three-year study of the cost of producing wheat in Sherman County, Oreg. Tabulation of data from the 1921 cotton-cost study has been completed and 200 new cotton-cost records have been obtained in Alabama. The rice-cost survey, begun late in the fiscal year 1921, has been practically completed; work on a study of potato costs has been brought to a close, and a preliminary survey has been made in the sugar-cane region of Louisiana with a view to making a study of the cost of producing sugar.

In a study of the cost of keeping horses and cost of horsepower, 274 records were obtained during the year. A report of this study has been submitted for publication.

Work has been completed on the summarization of available material on basic-cost factors of staple crops, and the results have been published in Department Bulletin 1000, Labor and Material Requirements of Field Crops, which constitutes a reference work in the field of cost studies. The results of these studies are summarized in the following table.

*Production costs of staple farm products.*

| Product. | Number of records. | Production cost investigations from which basic factors of cost were determined. | | | | | Trend of production costs compiled from basic factors expressed in index numbers—1913=100. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | State. | County. | Year. | Yield. | Average acre cost (net). | 1913 [1] | 1918 | 1920 | 1921 |
| Cotton | 89 | South Carolina | Anderson | 1918 | 248 pounds | $65.08 | 100 ($0.15) | 170 | 191 | 126 |
| Do | 75 | Texas | Ellis | 1918 | 176 pounds | 36.23 | 100 ($0.13) | 155 | 191 | 151 |
| Wheat | 284 | Kansas, Missouri, Nebraska | 9 counties | 1919 | 14.9 bushels | 27.80 | 100 ($1.04) | 168 | 209 | 171 |
| Do | 197 | North Dakota, South Dakota, Minnesota. | 5 counties | 1919 | 8.4 bushels | 22.40 | 100 ($0.99) | 173 | 225 | 166 |
| Corn | [2] 46 | Illinois | Cass, Minard, Sangamon. | 1917 | 46 bushels | 23.02 | 100 ($0.36) | 150 | 161 | 130 |
| Oats | [2] 38 | do | 4 counties | 1917 | 35.3 bushels | 14.50 | 100 ($0.32) | 141 | 166 | 142 |
| Sugar beets | 195 | Colorado | Greeley | 1917 | 15.57 tons | 86.95 | 100 ($3.93) | 159 | 173 | 118 |
| Do | 134 | Michigan | Tuscola | 1915 | 9.72 tons | 47.65 | 100 ($4.76) | 155 | 188 | 134 |
| Potatoes | 51 | Minnesota | Clay | 1919 | 103.1 bushels | 78.09 | 100 ($0.38) | 169 | 183 | 137 |
| Do | 50 | New York | Steuben | 1919 | 141 bushels | 96.14 | 100 ($0.43) | 142 | 229 | 123 |
| Hay (clover) | [2] 4 | Illinois | 4 counties | 1917 | 1.3 tons | 13.90 | 100 ($8.55) | 138 | 170 | 147 |
| Hay (mixed) | [2] 23 | New York | Several counties | 1913 | 1.4 tons | 14.21 | 100 ($10.15) | 148 | 192 | 136 |
| Barley | 33 | Colorado | Greeley | 1917 | 53.9 bushels | 40.55 | 100 ($0.56) | 138 | 155 | 131 |
| Alfalfa | 36 | do | do | 1917 | 3.43 tons | 35.37 | 100 ($7.70) | 140 | 157 | 130 |
| Beans | 26 | New York | Genesee | 1913 | 10.9 bushels | 40.65 | 100 ($3.73) | 170 | 177 | 135 |
| Do | 23 | Michigan | Tuscola | 1913 | 10.5 bushels | 29.34 | 100 ($2.79) | 165 | 179 | 128 |
| Apples | 218 | New York | 5 lake counties | 1915 | 84 barrels | 118.78 | 100 ($1.42) | 168 | 218 | 158 |
| Tobacco | [2] 81 | Kentucky | Fayette | [3] 1919 | 1,111 pounds | 289.10 | 100 ($0.13) | 176 | 223 | 167 |
| Do | [2] 70 | do | Christian | [4] 1919 | 825 pounds | 141.75 | 100 ($0.08) | 173 | 205 | 150 |
| Do | | do | do | [3] 1920 | 908 pounds | 295.73 | | | | |
| Do | | do | do | [4] 1920 | 855 pounds | 126.87 | | | | |
| Do | [2] 19 | Wisconsin | Dane | 1913 | 1,300 pounds | 61.00 | 100 ($0.05) | 158 | 196 | 138 |
| Kafir | 19 | Kansas | Cowley, Greenwood | 1917 | 23.2 bushels | 33.72 | 100 ($1.04) | 158 | 154 | 116 |
| Tomatoes | [2] 280 | New Jersey | | 1918 | 6.23 tons | 119.26 | 100 ($11.96) | 160 | 180 | 138 |
| Onions | [2] 16 | do | Cumberland | 1920 | 180 hampers | 291.97 | 100 ($0.88) | 162 | 185 | 140 |
| | | | | | *Cost per hundredweight.* | | | | | |
| Corn-fed cattle | [5] 5,000 | Nebraska | Burt | 1913–1921 | 1913—$8.75 | | 100 ($8.75) | 168 | 156 | 118 |
| Hogs | | Missouri | Lafayette | 1913–1921 | 1913—$7.22 | | 100 ($7.22) | 189 | 106 | 70 |

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[1] The 1913 unit cost was computed by using the average yield for the year of the inventory except in the case of wheat, where a 10-year average was used.

[2] Detailed cost accounting and route records.

[3] Dark tobacco.

[4] Burley tobacco.

[5] Number of head.

*Farm business analyses.*—During the year farm business analysis surveys, some of them involving enterprise cost studies, have been made as follows:

The tenth year in a representative area of the hill land of the Ohio River, Washington County, Ohio. (65 records.)

The fifth year in a representative truck farming area in Florida—Hillsboro County. (127 records.)

The fifth year in a representative citrus fruit area in Florida—Polk County. (154 records.)

Repetition of the survey in the cut-over land area of western Washington—King and Pierce Counties (200 farm business analysis records, and, in addition, 200 settlers' progress records). A farm business analysis study was made in the same area for the year 1915.

The third year of the study in the Palouse area, Washington and Idaho, and Sherman County, Oreg., including a cost-of-producing-wheat study. (400 records.)

The fourth year of a study of tractor farms in two areas in Ohio, including the cost-of-operating-a-tractor study. A cooperative study with the Ohio State College of Agriculture. (100 records.)

The first year of a continued study of dairy farming in Vermont. A cooperative study with the Vermont College of Agriculture. (200 records.)

The first year of a continued study in dry-land farming in four or five counties in Montana. In cooperation with Montana College of Agriculture. (180 records.)

The accompanying table shows some of the results obtained from these studies.

*Average farm income, labor income, per cent return on capital, and purchasing power of farm incomes in eight representative areas of the United States.*

| Area. | Number of farms. | Farm income.[1] | | | | Purchasing power of farm income.[2] | | | | Index of purchasing power of farm income. | | | | Labor income.[3] | | | | Per cent return on capital.[4] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1913 | 1918 | 1920 | 1921 | 1913 | 1918 | 1920 | 1921 | 1913 | 1918 | 1920 | 1921 | 1913 | 1918 | 1920 | 1921 | 1913 | 1918 | 1920 | 1921 |
| Cotton (1912): | | | | | | | | | | | | | | | | | | | | | |
| Sumter County, Ga. | 268 | $1,665 | $3,711 | $1,534 | $1,401 | $1,665 | $1,893 | $631 | $916 | 100 | 114 | 38 | 55 | $474 | $1,813 | −$364 | −$197 | 7.0 | 11.3 | 313 | 2.8 |
| Catawba County, N. C. | 297 | 413 | 985 | 383 | 224 | 413 | 503 | 158 | 146 | 100 | 124 | 38 | 35 | 87 | 542 | −60 | −219 | 2.3 | 6.4 | −.4 | −2.2 |
| Dairy: | | | | | | | | | | | | | | | | | | | | | |
| Hillsboro County, N. H. | 17 | 933 | 1,391 | 1,134 | 1,015 | 933 | 710 | 467 | 663 | 100 | 76 | 50 | 71 | 613 | 952 | 695 | 576 | 4.6 | 7.1 | 4.2 | 2.8 |
| Dane County, Wis. | 30 | 1,180 | 2,197 | 1,482 | 793 | 1,180 | 1,121 | 610 | 518 | 100 | 96 | 51 | 44 | 293 | 1,223 | 508 | −181 | 4.4 | (5) | (5) | (5) |
| Hog and cattle: | | | | | | | | | | | | | | | | | | | | | |
| Clinton County, Ind. | 100 | 1,503 | 2,978 | 1,222 | 555 | 1,503 | 1,519 | 503 | 363 | 100 | 102 | 37 | 24 | 256 | 1,421 | −335 | −1,002 | 4.7 | 7.9 | 2.2 | .1 |
| Tama County, Iowa. | [6] 965 | 2,607 | 4,570 | 1,637 | 570 | 2,607 | 2,331 | 674 | 373 | 100 | 89 | 26 | 14 | 306 | 1,537 | −1,396 | −2,463 | 4.8 | 5.6 | .8 | −1.0 |
| General live stock, Washington County, Ohio. | 25 | 421 | 719 | 445 | 157 | 421 | 367 | 183 | 103 | 100 | 87 | 43 | 24 | 110 | 333 | 31 | −257 | 2.2 | 4.8 | .9 | −2.6 |
| Wheat, Palouse (Washington and Idaho, 1914). | 246 | 2,357 | [7] 4,616 | 1,709 | 593 | 2,357 | 2,177 | 703 | 388 | 100 | 91 | 30 | 16 | 709 | [7] 1,826 | −1,080 | −2,197 | 7.0 | 7.7 | 1.4 | −.96 |

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[1] Farm income is the difference between receipts and expenses. The receipts consist of cash received for products, miscellaneous receipts, and the value of increased inventory. The expenses consist of cash payments, the value of services rendered by members of the farm family other than the operator himself, depreciation on buildings and equipment and decrease, if any, in the money value of the inventory. The farmer's own labor and interest on the value of the farm property are not included in the expenses. Farm income is a fund for current family use, which can not be overdrawn without impairing the capital employed. Due to interest on indebtedness and to the fact that a part of the farm income is often in goods rather than in cash and that the current financial needs of the business must be paid out of the farm income, it does not represent a sum altogether available for living expenses.

[2] The purchasing power was determined by dividing the figure for the farm income by the index number for wholesale prices established by the Department of Labor. The index numbers employed are as follows: 1913=100; 1918=196; 1919=212; 1920=243; 1921=153.

[3] Labor income is a phrase used to designate the residuum for the farmer's labor and managerial ability after deducting from the farm income interest on the value of the total investment. The interest rate employed has been 5 per cent but in the Georgia study 7 per cent and in the Palouse area 6 per cent were used.

[4] Per cent return on capital is the rate of interest returned on the value of the farm capital after deducting from the farm income the value of the farmer's labor.

[5] Data not available.

[6] 211 farms for 1918–1921.

[7] 1919.

NOTE.—The 1912, 1913, 1918, and 1919 figures for all regions are from actual business analysis records. The 1920 figures, with the exception of Washington County, Ohio, and the 1921 figures, have been computed from the data for 1918 or 1919.

*Land economics.*—Substantial progress has been made in the tabulation of data from about 160,000 farms with reference to the relation of cash rents to farm values, and of data from some 150,000 farms bearing on the question of ownership, extent of absentee ownership, etc. Of special significance at this time is the work that is being done under the direction of the committee on land utilization, which heads up in the section of land economics. This work looks to an estimate of the probable future land needs of the United States, and to a classification of all farm lands.

Studies of farm ownership in the Black Prairie of Texas (Dept. Bul. 1068); of the relation of land tenure to the use of arid grazing land in the Southwestern States (Dept. Bul. 1001); of harvest labor problems in the Wheat Belt (Dept. Bul. 1020); of farm lands available for settlement and of renting dairy farms (in Government Printing Office) have been completed.

Among studies in progress may be mentioned the following:

Systems of farm management and land tenure on southern plantations.
A study of Massachusetts farm labor in 1921.
Farm land capitalization.
Part owners as farmers.
Purchasing a farm.
How landowners fare on a group of Lake Agassiz Basin farms.

*Farm financial relations.*—During the year the section of farm financial relations has paid particular attention to certain phases of rural credits and to problems of crop insurance. Special studies as follows have been completed:

A study of cooperative short-time credit through local credit associations in the United States, with special reference to associations of this kind organized and operated in rural communities. (Department Circular 197.)

A study of farm-mortgage credit by banks, insurance companies, Federal and joint stock land banks, State funds, and mortgage companies, covering rates, term, method of repayment, etc. (Dept. Bul. 1047.)

A study of short-time bank loans to farmers, covering amount of such loans, seasonal fluctuations in amount, rates of interest, special requirements affecting costs of loans, nature of security for such loans, term of loans, etc. (Dept. Bul. 1048.)

A study of the problems of general crop insurance in the United States covering risks involved, experiments already made, and fundamental principles believed to underlie sound insurance for the grower of crops. (Dept. Bul. 1043.)

A study of the problem of adequate communication in country districts by means of the rural telephone. This study covers the development of telephone systems in rural districts, methods of obtaining telephone service with special attention given to methods of organizing and financing local companies where satisfactory service by the extension of existing companies is not available, cost of rural telephone service, and problems of operation and upkeep of rural lines. (Submitted for publication.)

Advice and assistance have been given a number of local farmers' mutual insurance companies in reorganizing and improving their method of business.

A special survey of credit and insurance conditions among farmers in selected areas in North Carolina is in progress, as is also a special study of mortagage indebtedness on farms operated by tenants and managers.

*Agricultural geography.*—The research in agricultural geography during the year has been devoted very largely to the compilation, mapping, and analysis of the returns of the 1920 Census of Agriculture.

In the project dealing with the distribution of farm enterprises, the census data have been compiled and mapped ready for presentation in the 1921 Yearbook, in which they will occupy about 125 pages.

In the study of geography of farm practices, labor requirements, and seasonal distribution of labor, investigators have copied all crop data contained in the 1919 county result slips of the census; made a percentage analysis of the crop area of each county; mapped the choice of hays, small grains, and row crops, and mapped the cropping systems of the Cotton Belt (1910 and 1920), Corn Belt (1920), together with the regions to the north and west of these belts (1920). Much of this material will appear in the Yearbook for 1921.

Preparatory to the study of live-stock systems of farming in the United States, two schedules have been prepared and sent out, through the Bureau of Markets and Crop Estimates, one a pasture schedule, that will provide the data necessary to divide the pasture acreage (census 1919) into rotation pasture, other tame grass pasture, different grades of wild-grass pasture, and browse pasture; the other, a live-stock schedule that supplies valuable information as to how crops and pasture are utilized by cattle, swine, sheep, horses, etc., on typical farms in different sections of the United States.

Those engaged in research in geographic conditions in relation to the utilization of land have also been devoting a great deal of time to the compilation of census statistics. Joint arrangements have been practically completed between this section and the Section of Land Economics to cooperate with the Bureau of the Census in tabulating the six questions relating to the use of land. These questions were not tabulated by the census, although the data are basic to an understanding of the use of land and the economic geography of American agriculture.

During the past year the "Precipitation and humidity" section of the Atlas of American Agriculture has been released for publication. The "Native vegetation" and "Temperature, sunshine, and wind" sections are ready to submit.

*Agricultural history.*—During the year work has been continued in the preparation of maps showing the shifts in crops, live stock, population, and farms from 1840 to 1920. This work is nearly completed. Some text has been prepared and text to be prepared for the 1921 Yearbook will contribute to the preparation of this work.

A field man spent several months in the Northern Great Plains collecting historical material relating to the development of the agriculture of that region, and valuable records relating to the cattle industry were obtained. Progress has been made toward organizing this material.

Study has been begun of the diaries and account books of several farmers covering a long period of years. Analysis of these diaries promises valuable information about farm organizations, source of income, cost of production, rate of accumulation, and conditions of living on the farm. The particular value of these records lies in the fact that they extend through long periods of time and enable the investigator to analyze the effect of changes in general economic conditions on the farm business, and also the effect of the age of the farm and of the farmer on the farm business.

Historical material has been prepared for the several articles of the 1921 Yearbook. Some of the maps showing shifts in agricultural enterprises will be included in these articles, as well as data on the trend of production and prices of certain agricultural products.

*Rural life studies.*—During the year a number of studies have been made of rural population groups in cooperation with various State colleges, and work has been begun on the tabulation of farm-population data collected in the 1920 census. Among projects completed or well along toward completion may be mentioned the following:

A study of French Creek, W. Va., as a rural community. Completed and results published by the College of Agriculture of West Virginia (Bul. No. 176).

A study of a farm community at Belleville, N. Y. Completed and results published in Department Bulletin 984. The National Influence of a Single Farm Community.

A study of the social aspects of farm tenancy. Tabulation completed for 16 States. A manuscript on the study in North Dakota has been prepared for publication by the North Dakota State College.

Social aspects of sales of farms. Final tabulation being made. To be published by the College of Agriculture of Purdue University, Ind.

Country planning. Work on manuscript of bulletin nearly completed.

The story of one hundred farm women. Field work completed and text of three bulletins in preparation.

Standards of living among American farmers. Field work of a study in New York State completed and tabulation in progress.

Farm population (census study). Tabulation in progress of farm population of Ellis County, Tex.; Dane County, Wis.; Wake County, N. C.; King County, Wash.; Cass County, N. Dak.; Otsego County, N. Y.; and Scott and Madrid Counties, Mo.

Analysis of counties into primary population groups. Work is in progress on studies of Raballi County, Mont.; Otsego County, N. Y., and Wake County, N. C., and a study has been completed for Dane County, Wis. The results of the Dane County study have been published in Research Bulletin 51 of the University of Wisconsin, entitled "Rural Primary Groups."

Function of farmers' trade and service agencies. Field work completed of study in Webster City, Iowa, and Alexandria, La.

Rural social organizations. Study in progress in Texas.

Rural community buildings. Text prepared for proposed Farmers' Bulletin, Uses of Rural Community Buildings.

*Extension work.*—The extension work of the Office of Farm Management and Farm Economics is conducted in cooperation with the States Relations Service. The work deals with the teaching of the fundamental principles underlying the successful organization and operation of the farm. The media employed have been farm-management schools, boys' and girls' clubs, rural schools, and general publicity meetings. Farmers' organizations, bankers' associations, State and county school officials, and others have taken an active part in this work. Over 800 farm-management schools, with an attendance of 20,000, were held in 1921. Reports show that in 895 communities, 50,083 account books were distributed. In 519 counties, 18,448 books actually were kept by farmers, and in 444 counties, 8,450 farmers were assisted in summarizing their accounts. In 237 counties 2,972 farmers made changes in their farm business as a result of keeping farm accounts.

The Office of Farm Management and Farm Economics has given special attention to the problems of organization and practice in the South. Due to changing economic conditions and the persistent advance and intense activities of the boll weevil, southern agriculture is passing through a period of readjustment. To aid the southern farmers in making the best readjustment possible, the office has assembled, analyzed, and put in suitable form information relative to labor requirements, labor distribution of different enterprises, and other basic factors essential to the proper adjustment of crop enterprises and the proper management of the farm. This material has been distributed through the county agents, teachers, and others interested in the farmers' economic problem. As a result, the demand for our investigational material has been great and applications have been received for research cooperation with five Southern States with which we are at present not cooperating and additional funds have been requested by those States with which we are cooperating.

During the past year the office has been able to place before the extension men and others interested in agricultural progress up-to-date terse information regarding the investigation and extension work of the office. In view of the significant economic developments of the last two years, emphasis has been placed on information dealing with the trend of production, prices, movement of production, and the changing status of the farmer relative to other groups of producers. This information has been carried on mimeographed summary sheets sent out the first day of each month. In this work the office has cooperated with other divisions of the department, especially with the Bureau of Markets and Crop Estimates.

## PUBLICATIONS OF THE OFFICE OF FARM MANAGEMENT AND FARM ECONOMICS.

NOTE.—"Arrangements have been perfected for carrying on under one central authority (in the Bureau of Plant Industry) a system of work which we have designated as 'farm management.' This work has been placed in the hands of Prof. W. J. Spillman."—*Ann. Rept. of U. S. Dept. of Agric. for year ending June 30, 1902, pp. 54, 55.*

In the interval between this time and the formal organization of the Office of Farm Management, July 1, 1905, certain bulletins relating to work later carried on by the Office of Farm Management were published as contributions of the grass and forage plant investigations of the Bureau of Plant Industry under the direction of Professor Spillman or as Yearbook separates.

July 1, 1920, the name was changed to the Office of Farm Management and Farm Economics.

### INTRODUCTORY LIST, JANUARY, 1902–JULY, 1905.

[See also B. P. I. Bulletins Nos. 4, 12, 13, 15 as immediately preceding.]

#### BUREAU OF PLANT INDUSTRY BULLETINS.

No. 38. Forage conditions and problems in eastern Washington, eastern Oregon, northwestern California, and northwestern Nevada. By David Griffiths. 1903.

No. 57. Methods used for controlling and reclaiming sand dunes. By A. S. Hitchcock. 1904.

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No. 851. Cost of producing apples in five counties in western New York, 1910–1915. By G. H. Miller. 1920. 10 cents.

No. 853. Organization and management of farms in northwestern Pennsylvania. By E. D. Strait and H. M. Dixon. 1920. 10 cents.

No. 874. Farm land values in Iowa By L. C. Gray. 1920. 5 cents.

No. 896. Cost of producing cotton (842 records—1918). By L. A. Moorhouse and M. R. Cooper. 1920. 15 cents.

No. 910. Experience of eastern farmers with motor trucks (753 reports). By H. R. Tolley and L. M. Church. 1920. 10 cents.

No. 912. Hail insurance on farm crops in the United States. By V. N. Valgren. 1920. 10 cents.

No. 917. Farm practice in growing field crops in three sugar-beet districts of Colorado. By S. B. Nuckols and Thomas H. Summers. 1921. 20 cents.

No. 920. Farm profits—figures from the same farms (in Washington County, Ohio; Clinton County, Ind.; and Dane County, Wis.) for a series of years. By H. M. Dixon and H. W. Hawthorne. 1920. 15 cents.

No. 931. Corn belt farmers' experience with trucks (831 reports). By H. R. Tolley and L. M. Church. 1921. 10 cents.

No. 941. Farm management in the Ozark region of Missouri. By H. M. Dixon and J. M. Purdom. 1921. 15 cents.

No. 943. Cost of producing wheat on 481 farms... for the crop year 1919. By M. R. Cooper and R. S. Washburn. 1921. 15 cents.

No. 961. Standards of labor on the hill farms of Louisiana. By M. Bruce Oates and L. A. Reynoldson. 1921. 10 cents.

No. 963. Cost of producing sugar beets in Utah and Idaho. 1918–19. By L. A. Moorhouse and S. B. Nuckols. 1921. 10 cents.

No. 968. Buying farms with land-bank loans. A study based on the experience of 2,700 farmers who have borrowed money through Federal loan banks. By L. C. Gray and Howard A. Turner. 1921. 5 cents.

No. 984. The national influence of a single farm community. By Emily F. Hoag. 1921. 20 cents.

No. 994. Methods of conducting cost of production and farm organization studies. By F. W. Peck. 1921. 5 cents.

No. 997. The cost and utilization of power on farms where tractors are owned. By H. R. Tolley and L. A. Reynoldson. 1921. 10 cents.

No. 1000. Labor and material requirements of field crops. By L. A. Moorhouse and O. A. Juve. 1922.

No. 1001. The relation of land tenure to the use of the arid grazing lands of the Southwestern States. By E. O. Wooten. 1922.

No. 1020. Harvest labor problems in the Wheat Belt. By D. D. Lescohier. 1922. 10 cents.

No. 1043. Crop insurance: Risks, losses and principles of protection. By V. N. Valgren and E. E. Engelbert. 1922. 5 cents.

No. 1047. Farm mortgage loans by banks, insurance companies and other agencies. By V. N. Valgren and E. E. Engelbert. 1922. 5 cents.

No. 1048. Bank loans to farmers on personal and collateral security. By V. N. Valgren and E. E. Engelbert. 1922. 5 cents.

### DEPARTMENT CIRCULARS.

No. 77. Suggestions for a State law providing for the organization of farmers' mutual fire insurance companies. By V. N. Valgren. 1920. 5 cents.

No. 83. Testing farms in the South for efficiency in management. By C. L. Goodrich. 1920. 5 cents.

No. 197. The credit association as an agency for rural short-time credit. By V. N. Valgren and E. E. Engelbert. 1921. 5 cents.

### OFFICE OF THE SECRETARY CIRCULARS.

No. 36. Emergency forage crops. By D. A. Brodie. 1911.

No. 53. Formulæ for calculating interest on farm equipment. By W. J. Spillman. 1915.

No. 54. A system of pasturing alfalfa in Salt River Valley, Ariz. By R. W. Clothier. 1915.

No. 57. The influence of relative area in intertilled and other classes of crops on crop yield. By D. A. Brodie. 1916.

No. 67. Measuring hay in ricks or stacks. By H. B. McClure and W. J. Spillman. 1916.

### DEPARTMENT REPORTS.

No. 96. Soils of the prairie regions of Alabama and Mississippi and their use for alfalfa: Part I. Houston clay and associated soils. By H. H. Bennett. Part II. Alfalfa on the Houston clay; its culture and management. By M. A. Crosby. 1911.

No. 111. Meat situation in the United States: Part III. Methods and cost of growing beef cattle in the Corn-Belt States. By J. S. Cotton, M. O. Cooper, W. F. Ward, and S. H. Ray. 1916.

### FARM-MANAGEMENT CIRCULARS.

No. 1. Suggestions concerning checking and tabulating farm-management data. By W. J. Spillman. 1916. 5 cents.

No. 2. Plan for handling the farm-labor problem. 1917.

No. 3. A method of testing farms in the South for efficiency in management. By C. L. Goodrich. 1919.

### MISCELLANEOUS.

Geography of the world's agriculture. By V. C. Finch and O. E. Baker. 1917.

Atlas of American Agriculture: Part II. Section 1. Frost and the growing season. By W. G. Reed. 1918. 75 cents. Part V. Section A. Cotton. By O. C. Stine and O. E. Baker. 1918. 50 cents. Part IX. Section 1. Rural population. By E. A. Goldenweiser. 1919. 50 cents.

Directory of American agricultural organizations. 1920. 10 cents.

# REPORT OF THE PACKERS AND STOCKYARDS ADMINISTRATION.

United States Department of Agriculture,
Packers and Stockyards Administration,
*Washington, D. C. September 9, 1922.*

Sir: I submit herewith the first report of the Packers and Stockyards Administration.

Respectfully,

Chester Morrill,
*Assistant to the Secretary.*

Hon. H. C. Wallace,
*Secretary of Agriculture.*

This is the first report of the Packers and Stockyards Administration. It covers the period from the date of the passage of the packers and stockyards act, 1921, on August 15, 1921, to the end of the fiscal year, June 30, 1922. Substantial progress has already been made in the development of the organization under the act and the accomplishment of its purposes, notwithstanding the embarrassment caused for several months by the litigation instituted by certain commission men and traders to test the constitutionality of the new statute.

The live-stock and meat-packing industry, taken altogether, is more important, if not in fact larger, than any other single class of business in the whole industrial organization of our country, and for a long time prior to the passage of the packers and stockyards act a general impression existed, especially among live-stock producers, that conditions prevailing in the live-stock markets and the meat-packing industry were such that the Federal Government should exercise general supervisional authority over the various phases of this great activity. There had arisen a general lack of confidence, as well as deep-seated dissatisfaction, with reference to the manner in which the live-stock marketing machine was functioning. There were known to be certain specific evils which the legitimate elements in the industry disapproved but found it difficult to combat, and which apparently could be dealt with only through some disinterested party. There was serious controversy as to what were the facts bearing upon important phases of the business, and leaders in the industry came to see that intelligent supervision should be beneficial.

In substance, the act charges the Secretary of Agriculture with the duty of preventing and correcting irregularities or abuses on the part of persons engaged in the live-stock and meat-packing industry, such as unfair, discriminatory, or deceptive practices, or the control of prices or the establishment of monopolies, and with the supervision and control of the rates and charges of the stockyards companies and market agencies at the various public stockyards throughout the country. The assurance of open competitive market conditions and reasonable marketing costs in the live-stock and meat-packing industry is the prime purpose of this statute. In addition to the powers specifically conferred on the Secretary of Agriculture, those possessed by the Federal Trade Commission with respect to the enforcement of the provisions of the Federal Trade Commission act in connection with unfair methods of competition are granted also to the Secretary of Agriculture for the enforcement of the packers and stockyards act. On the other hand, the full effect of the existing antitrust laws of the country remains unimpaired. Not the least important responsibility placed upon the Secretary of Agriculture is that of gathering and determining facts about which there has been so much controversy and publishing them from time to time, even when they show that complaints have been unjustified.

## THE PACKERS AND STOCKYARDS ADMINISTRATION.

The packers and stockyards act, 1921, Public No. 51, Sixty-seventh Congress, was approved August 15, 1921. As the Secretary of Agriculture is charged with the enforcement of this statute, he began immediately to develop plans for its administration. An estimate of the amount of funds required to defray expenses for the remainder of the fiscal year ending June 30, 1922, was submitted to Congress, and $200,000 was provided in the deficiency act of August 24, 1921. As a means of effective administration, and in order that the Secretary might give his close personal attention directly to its activities, the Packers and Stockyards Administration was created as a separate unit of the department under an assistant to the Secretary, who reports directly to the Secretary. This officer was designated on September 6, 1921, and began immediately the formation of the organization and the work of carrying out the purposes of the law. The first work was that of securing competent associates for the purpose of handling the different phases of the work as it developed. These phases were naturally grouped into five parts:

1. Administrative.
2. Law.
3. Audits and accounts.
4. Rates, charges, and registrations.
5. Trade practices.

This does not constitute a separation of the work into projects, but is solely a division of administrative labor in order that matters needing attention may be handled properly and by persons having definite responsibility therefor.

The development of the organization has shown the need for the utmost flexibility and coordination of effort, particularly in the development of policies, so that no one branch of the work may be carried on without full cognizance of the activities in the other branches.

For the handling of the multitude of administrative matters that necessarily arise in such an organization, and in order that the benefits of the existing experience of the department might be retained in full measure, Stephen Bray, specialist in marketing live stock and meats, who was head of the live stock and meats division of the Bureau of Markets and Crop Estimates, was selected as general assistant to the officer in charge, and George T. Ash, who for years had served in the Division of Accounts and Disbursements of the Department of Agriculture, was appointed chief clerk of the new organization.

For handling legal questions, Judge Bayard T. Hainer, a man of mature years, a former Federal judge in the State of Oklahoma, who had also been engaged for a considerable time in the active general practice of the law, was selected as attorney.

The work connected with the auditing of the books of the various persons subject to the act and the study and analysis of their accounting systems was placed under the direction of Arthur S. French, a certified public accountant, who had had considerable experience of responsible character in public accounting work in the Middle West.

The duties relating to the registration of market agencies and dealers at the various public stockyards and the determination of questions relating to the reasonableness of rates and charges were assigned to G. N. Dagger, specialist in live-stock marketing costs, who had had considerable training along both economic and legal lines and, having previously been engaged both in live-stock farming and in State public activities, possessed highly desirable qualifications for this work.

The questions of trade practices in the marketing of live stock being of the utmost importance, Howard M. Gore, of West Virginia, a lifelong cattle and sheep raiser, who had been president of the Hereford Breeders' Association of West Virginia and a member of the board of education of that State, and who had banking and other interests which brought him a thorough knowledge of general business methods, and who, in addition, had served as a producer on the committee of fifteen of the American Farm Bureau Federation in the consideration of plans for the cooperative marketing of live stock, was selected to handle trade practices.

Provision has been made also for the handling of certain economic phases of the work of the Packers and Stockyards Administration, under the immediate direction of Charles J. Brand, after July 1, 1922, as consulting specialist in marketing in the Department of Agriculture, who established the Office of Markets, later the Bureau of Markets, of the Department of Agriculture, and continued with it until 1919, since which time he has been vice president and general manager of a nation-wide commercial fruit and vegetable marketing organization, in which capacity he has had unusual opportunity to familiarize himself from a nongovernmental standpoint with the commercial aspects of marketing and distribution questions.

The work to be done in the various public stockyards throughout the country necessitated the use of men who by training and experience were familiar with the practical phases of the marketing of live stock through terminal markets, who should act as live stock market supervisors and their assistants at the more important public stockyards. On June 30 such men had been assigned to the stockyards at the following markets:

Atlanta, Ga.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, Ohio.
Denver, Colo.
Detroit, Mich.
El Paso, Tex.
Fort Worth, Tex.
Indianapolis, Ind.
Kansas City, Mo.
Nashville, Tenn.
National Stock Yards, Ill.
New York, N. Y.
Omaha, Nebr.
Pittsburgh, Pa.
North Portland, Oreg.
San Francisco, Calif.
Sioux City, Iowa.
South St. Paul, Minn.

Other public stockyards to which such men had not been assigned were handled by placing them under the supervision usually of the nearest supervisor, who is required to visit such markets from time to time for the purpose of giving attention to such matters as require action. A plan is being developed whereby in markets which require more attention than can be given on occasional short visits, but which do not seem to require permanent supervisors, there will be placed from time to time supervisors who will remain in the markets for periods of a month or longer until the policies and requirements of the Packers and Stockyards Administration are fully understood, when such supervisors will proceed to other markets for similar work. Through the medium of these local market supervisors, an important policy that it was indicated in the debates preceding the passage of the packers and stockyards act should be carried out is being put into execution. This involves the handling, as far as possible, of local matters through informal adjustment on the ground without the necessity for formal proceedings or reference of the matters in question to Washington before action is taken thereon. In this way unnecessary delays are avoided and meritorious complaints receive prompt attention.

As a means of coordinating the activities of the various supervisors and giving assurance that they are proceeding in accordance with a common and well-thought-out policy, every supervisor reports to Washington once a week all of the activities in which he has participated during the previous week, and a summary of these reports is furnished to all the supervisors. There is also in process of development a plan by which all of the markets will be handled in four general divisions, each under a division supervisor who will be responsible for the conduct of the work of the supervisors in his division. This will be an additional assurance of uniform and proper application of the provisions of the packers and stockyards act.

In addition to the supervisors in the various markets, a field organization of competent accountants is in process of development, with the expectation that specially qualified men will be assigned at central points from which they can carry on the investigational work of an auditing character which is necessary to supplement the activities of the supervisors and to furnish the administration with information required in order to determine facts as to the reasonableness and justice of rates and charges, as well as such information as may be desired on the economic phases of the live-stock and meat-packing industry that may be gathered from a study of the financial and other records of persons subject to the act. Special investigators to handle more or less isolated questions that arise from time to time will also be utilized.

As a means of insuring a common understanding on the part of all responsible members of the Packers and Stockyards Administration, including particularly the live-stock market supervisors, a meeting of the supervisors was held in Washington during the week beginning April 24, 1922. At this meeting there were considered all of the various questions which had arisen in the experience of the supervisors or the Washington office, and uniform conclusions were reached as far as possible on the questions of policy. This meeting enabled the Washington office to send the supervisors back into the field with confidence that they should carry out the provisions of the packers and stockyards act in a more intelligent way than could possibly have been accomplished merely through correspondence. In view of the very great benefits resulting from this conference, other similar conferences will be held from time to time not less often than once a year.

## AGENCIES SUBJECT TO THE ACT.

The act went into effect immediately upon its passage as to packers who are subject to Title II, and no registration or other special formality was necessary in order to bring them within its provisions. On the other hand, market agencies and dealers covered by Title III of the law were not subject to its provisions until there had been inquiry, formal determination, and public notice as to the stockyards that were embraced within its operation. Consequently, this was among the first of the activities of the Packers and Stockyards Administration.

Up to June 30, 1922, it had been ascertained in accordance with the provisions of the act that 78 stockyards, listed below, located in 70 cities in 35 States, are subject to the provisions of Title III as public stockyard markets, and prior to June 30, 1922, 69 of these stockyards were formally posted as required by law. The names of the stockyards companies, the places where located, and the dates upon which their stockyards were posted are set out below. Where no date is shown the posting took place after June 30 and will be covered in the next annual report:

| Name of yard. | City. | Date posted. |
|---|---|---|
| Western Stockyards | Amarillo, Tex | |
| New Orleans Stockyards (Inc.) | Arabi, La | Nov. 1, 1921 |
| Miller Union Stockyards | Atlanta, Ga | Do. |
| J. W. Patterson Commission Co | do | Apr. 1, 1922 |
| Suttles, Bragg & Millsaps | do | Do. |
| Augusta Stockyard Co | Augusta, Ga | Nov. 1, 1921 |
| Union Stockyard Co | Baltimore, Md | Do. |
| Union Stockyards Co. of New Jersey | Benning, D. C | Do. |
| Birmingham Stockyards Co | Birmingham, Ala | Do. |
| Brighton Stockyards Co | Brighton, Mass | Do. |
| New York Central Railroad Co | Buffalo, N. Y | Do. |
| Foust-Yarnell Stockyards | Chattanooga, Tenn | Do. |
| Pursley Stockyards | do | |
| Union Stockyard & Transit Co. of Chicago | Chicago, Ill | Do. |
| Cincinnati Union Stockyard Co | Cincinnati, Ohio | Do. |
| Cleveland Union Stockyards Co | Cleveland, Ohio | Do. |
| Columbia Stockyards Co | Columbia, S. C | Do. |
| Drovers Union Stockyards | Columbus, Ohio | Do. |
| Union Stockyards | Dallas, Tex | |
| Union Stockyards Co | Dayton, Ohio | Do. |
| Denver Union Stockyards Co | Denver, Colo | Do. |
| Michigan Central Railroad Co | Detroit, Mich | Do. |
| Dublin Stockyards (Inc.) | Dublin, Ga | Do. |
| El Paso Union Stockyards Co | El Paso, Texas | Do. |
| Independent Union Stockyards Co | do | Do. |
| Evansville Union Stockyard Co | Evansville, Ind | Do. |
| Fort Wayne Union Stockyards | Fort Wayne, Ind | |
| Fort Worth Stockyards Co | Fort Worth, Tex | Do. |
| Fostoria Union Stockyards Co | Fostoria, Ohio | Do. |
| Belt Railroad and Stockyards Co | Indianapolis, Ind | Do |
| National Stockyards | Jacksonville, Fla | Do. |
| The Jersey City Stockyards Co | Jersey City, N. J | Do. |
| Kansas City Stockyards Co | Kansas City, Mo | Do. |
| East Tennessee Stockyards | Knoxville, Tenn | Do. |
| Lafayette Union Stockyard Co | Lafayette, Ind | Do. |
| Union Stockyard Co | Lancaster, Pa | Do. |
| Bourbon Stockyards Co | Louisville, Ky | Do. |

| Name of yard. | City. | Date posted. |
|---|---|---|
| Marion Union Stockyards Co | Marion, Ohio | Nov. 1, 1921 |
| Jos. A. Maxwell & Sons Com. Co | Memphis, Tenn | Do. |
| Dixie National Stockyards | do | Do. |
| South Memphis Stockyards | do | Do. |
| Milwaukee Stockyards Co | Milwaukee, Wis | Do. |
| Union Stockyards Co. of Montgomery (Inc.) | Montgomery, Ala | Do. |
| Moultrie Stockyards | Moultrie, Ga | Do. |
| Nashville Union Stockyards (Inc.) | Nashville, Tenn | Do. |
| St. Louis National Stockyards Co | National Stock Yards, Ill | Do. |
| Newark Stockyards | Newark, N. J | Do. |
| New York Stockyards | New York, N. Y | Do. |
| Union Stockyards | Norfolk, Va | May 1, 1922 |
| Portland Union Stockyards Co | North Portland, Oreg | Nov. 1, 1921 |
| Salt Lake Union Stockyards | North Salt Lake, Utah | Do. |
| Union Stockyards | Ogden, Utah | Do. |
| Oklahoma National Stockyards Co | Oklahoma City, Okla | Do. |
| Pasco Union Stockyards Co | Pasco, Wash | Do. |
| Peoria Union Stockyards Co. (Inc.) | Peoria, Ill | Do. |
| West Philadelphia Stockyard Co | Philadelphia, Pa | Do. |
| Pittsburgh Union Stockyards Co | Pittsburgh, Pa | Do. |
| Pueblo Union Stockyards | Pueblo, Colo | Mar. 1, 1922 |
| Richmond Union Stockyards Co | Richmond, Va | Oct. 31, 1921 |
| Southern Stockyards Corporation | do | Do. |
| Union Stockyards, S. A | San Antonio, Tex | Nov. 1, 1921 |
| Sioux City Stockyards Co | Sioux City, Iowa | Do. |
| Sioux Falls Stockyards Co | Sioux Falls, S. Dak | Do. |
| Union Stockyards Co | Seattle, Wash | Do. |
| Union Stockyards Co. of Omaha (Ltd.) | South Omaha, Nebr | Do. |
| St. Joseph Stockyards Co | South St. Joseph, Mo | Do. |
| St. Paul Union Stockyards Co | South St. Paul, Minn | Do. |
| Spokane Union Stockyards Co | Spokane, Wash | Do. |
| Springfield Union Stockyards Co | Springfield, Ohio | Do. |
| Inter-State Stockyards Co | Toledo, Ohio | Do. |
| Toledo Union Stockyards Co | do | Do. |
| Wichita Union Stockyards Co | Wichita, Kansas | Do. |
| Patrick Horan & Sons Stockyards | West Albany, N. Y | Do. |
| The Billings Stockyards | Billings, Mont |  |
| Union Stockyards | Caldwell, Idaho |  |
| The Laramie Stockyards | Laramie, Wyo |  |
| Union Stockyards | Laredo, Tex |  |
| The Oregon Shortline Railroad Stockyards | Pocatello, Idaho |  |

The posting of these yards brings into play the provision of the law which requires that all market agencies and dealers, as these terms are defined in the act, that are engaged in business in these yards shall register with the Secretary of Agriculture within 30 days after the posting, and thereafter that no new market agency or dealer shall engage in business without having registered. During the pendency of the litigation involving the constitutionality of the act many market agencies and dealers refused to register and many others registered under protest, but it is now believed that practically all market agencies and dealers in the various stockyards have registered, and there were on file on June 30 the registrations of 3,436 dealers and 1,075 market agencies. As a means of making certain that every market agency and dealer registered with the Packers and Stockyards Administration had knowledge that such registration had been received and of the provisions of the packers and stockyards act and the regulations thereunder, a printed pamphlet containing the act and the regulations and a certificate of registration was mailed under registered cover to each registrant.

The posting of the various yards also rendered operative the provision of the law requiring that within 60 days after such posting the stockyard owners and every market agency in the yards posted should file with the Secretary of Agriculture their schedules of rates and charges and any rules or regulations affecting the value of services rendered. On June 30, 1922, these schedules of rates and charges had been filed by practically all of the persons required to do so.

## GENERAL RULES AND REGULATIONS.

The provisions of Title II of the act with respect to packers were practically self-operative immediately upon the passage of the act, but it was deemed necessary to establish certain general rules and regulations under Title III as to stockyard owners, market agencies, and dealers, to cover certain matters with respect to which the requirements of the Secretary of Agriculture might not otherwise be fully understood. Consequently, tentative rules and regulations with respect to stockyard owners, market agencies, and dealers were prepared and furnished to all classes of persons interested for suggestions and criticism, and public hearings were held as follows:

Portland, Oreg., Nov. 8, 1921.
Denver, Col., Nov. 12, 1921.
Fort Worth, Tex., Nov. 14, 1921.
Kansas City, Mo., Nov. 15, 1921.
Chicago, Ill., Nov. 18, 1921.

After full consideration had been given to the information received through the medium of these hearings and correspondence, the formal general rules and regulations of the Secretary of Agriculture were issued on November 30, 1921, as Circular No. 156 of the Office of the Secretary.

At the close of the fiscal year, regulations governing the procedure in formal proceedings under the packers and stockyards act were in course of preparation, based upon our practical experience in handling such matters.

## LITIGATION.

About the time of the issuance of the formal general rules and regulations of the Secretary of Agriculture, a suit was instituted in the Federal district court at Chicago by certain commission men and traders who do business in the Chicago stockyards to enjoin the Government from carrying out the provisions of the packers and stockyards act, with special reference to commission men and traders, it being asserted that the act was unconstitutional as to such persons and that the definition of interstate commerce in the act exceeded the authority of Congress. The attorney for the Packers and Stockyards Administration represented the Government before the district court at Chicago and assisted the Solicitor General of the United States in the preparation of the briefs presented to the Supreme Court of the United States. While this litigation was pending, the commission men and dealers, although promising cooperation with the Packers and Stockyards Administration in the event the suit was decided in favor of the Government, not only in Chicago but to a considerable extent in other markets influenced by Chicago, were unwilling to comply with the requirements of the law, and the Packers and Stockyards Administration was delayed and embarrassed in its work. The case was heard before Federal Judges Evans, Landis, and Fitz Henry, who joined in a clear and clean-cut decision upholding it, and declined to grant even a temporary injunction or stay; but the case was appealed immediately to the Supreme Court of the United States, and, pending its determination, the enforcement of the law as to the Chicago appellants was suspended. The Supreme

Court on May 15, 1922, upheld the decision of the lower court, expressly sustaining the constitutionality of the act and the validity of the definition of interstate commerce, which is somewhat broader than had been carried in any previous statute, although the basis for such a definition had been established by earlier decisions of the Supreme Court. Immediately following the decision of the Supreme Court, the commission men and traders generally announced their intention to cooperate with the Packers and Stockyards Administration and to comply with the law in every respect.

Certain statutes of the State of Minnesota, passed prior to the enactment of the packers and stockyards act, vest the railroad and warehouse commission of that State with authority to supervise the operations of the public stockyards and the commission men and traders in that State, to regulate rates and charges, and to maintain State weighers in the stockyards. The enactment of the packers and stockyards act raised the question of the validity of the continued enforcement of these statutes, and because of the fact that the State supervision was maintained by the imposition of a special charge per head for State weighing collected from the shippers of all live stock marketed in the St. Paul stockyards, and that no similar charge was imposed at other stockyards in the country, complaint was made on behalf of shippers outside of Minnesota that this charge should not be allowed. This caused an investigation by the Packers and Stockyards Administration of the whole situation, and it was found that the railroad and warehouse commission was contending that its jurisdiction should be maintained unimpaired and that the weighing service and the charges therefor should not be disturbed. It appeared that there was a question of conflict of jurisdiction which was considered by the attorney of the Packers and Stockyards Administration, who decided that the packers and stockyards act covered the whole field involved in the question and that the State laws were in conflict therewith and therefore invalid as to interstate commerce. This opinion was sustained by the Attorney General of the United States. At this stage the stockyards company proposed to take over the entire weighing service and the dockage and shrinkage of hogs and absorb the expense without special charges to the shipper and without increasing its existing rates. The annual revenues of the State amounted to from $60,000 to $75,000 per annum from these sources. The State thereupon instituted suit in the State court to enjoin the stockyards company from taking this action, and later the commission men instituted suit in the Federal district court to enjoin the State from enforcing its laws. The State railroad and warehouse commission also procured the introduction in the House of Representatives of an amendment to the packers and stockyards act designed to retain for the State its jurisdiction over the weighing of live stock and the bonding of commission men. Public hearings were held by the House Committee on Agriculture, where all interests were represented, and the facts of the situation were brought to the attention of the committee by the officer in charge of the Packers and Stockyards Administration. The amendment was not reported out by the committee. Following this a representative of the Packers and Stockyards Administration was sent to St. Paul for the purpose of bringing about some equitable disposition of the matter which would be fair to all parties and which would at the same time retain for the Secretary of Agriculture full authority to carry out the purposes of the packers and stockyards act. These matters were pending at the close of the fiscal year, with prospects of satisfactory adjustment through the means of a plan by which the special weighing charge would be discontinued and the stockyards company would pay the salaries of the State weighers who would continue to weigh live stock, but with full recognition by the State of the authority of the Packers and Stockyards Administration over the subject matter involved, pending the final determination by the Supreme Court of the United States, on appeal from the decision in the Federal court, of the question of conflict of jurisdiction.

### AUDITS AND REPORTS.

For the period of two months, November and December, 1921, and quarterly thereafter reports are being obtained from commission men in the various markets as to their earnings and expenses according to a simple classification designed to keep the Packers and Stockyards Administration in touch with the financial condition of the commission men, in order that it may observe variations bearing upon the question of reasonableness of rates and charges and other questions, and be in a position to deal intelligently with the necessity for special investigations in particular markets from time to time. These reports include certain items of special interest, such as the expense of advertising the business. It is found in this connection that a comparatively small percentage of the total number of commission men in the country keep adequate accounts, and therefore it has become apparent that the Packers and Stockyards Administration must devote study to proper accounting systems for commission men.

In order to throw light on controversies that had arisen as to the facts of the commission business, and in anticipation of the necessity for making future determinations as to the reasonableness of the rates exacted by commission men in various markets an audit of the books of commission men was arranged for with certain representatives of the exchanges and started in St. Paul, Omaha, Fort Worth, Pittsburgh, Pa., and Portland, Oreg., these five markets being selected with a view to the representation of distinctly different marketing conditions in widely separated parts of the country. This audit included the tabulation from the account sales of the commission men for 1921 of all of the items of expenditure in connection with the sale of the live stock and of the information relating to the kinds and weights of live stock marketed and the classes of buyers. This work had not been completed at the close of the fiscal year, up to which time no formal complaints against commission rates had been filed, but indications had been received that such complaints would be filed during the next fiscal year. The work of auditing the accounts of the commission men in the various markets was planned so as to be coordinated with the work of the Bureau of Markets and Crop Estimates in ascertaining the costs of marketing live stock, with a view ultimately to enabling the Department of Agriculture to state the costs all the way through from the producer to the consumer. In addition to these planned audits, there have been certain incidental audits of commission men's books in other markets for the purpose of special investigations.

The various audits have disclosed irregularities concerning which regulatory action has been taken or is planned for the purpose of bringing about improved conditions. It has been discovered in several of the markets that commission men were continuing in business when their assets were insufficient to enable them to settle with the producers whose live stock they had sold. These cases were given the necessary immediate corrective attention, and the question has been taken up with the various markets of requiring commission men to keep the proceeds of sale of live stock belonging to their shippers in separate bank accounts and to give surety company bonds for the protection of their shippers. In some markets bonds are already in force, and in at least one large market the commission men several years ago voluntarily put into effect a separate banking system for the proceeds of sale of live stock. By cooperation with the Packers and Stockyards Administration in another market a system of separate bank accounts was being developed at the close of the fiscal year.

Reports were obtained from packers engaged in interstate commerce throughout the country showing the financial aspects of their operations during 1921, and at the close of the fiscal year the information contained in these reports was being consolidated and compiled in tabulated form, and plans were being made for a systematic study of the accounting systems of the packers as soon as the other pressing work of the accountants of the Packers and Stockyards Administration would permit.

## TRADE PRACTICES HANDLED INFORMALLY.

Whenever it is possible to anticipate a condition that may be productive of complaint, or when complaints are actually filed, the Packers and Stockyards Administration endeavors immediately to make the necessary investigation and to bring about whatever corrective action may be justified through informal methods and the agreement of the parties affected. It is quite apparent that when this is possible the results are accomplished with much less expenditure of labor and expense and with the greater likelihood of permanent beneficial results than when matters are allowed to reach the extremely controversial stage of formal proceedings with the attendant possibilities of suspension by later court action. Therefore the number of formal proceedings is being kept at a minimum, and such formal proceedings do not represent entirely the results of the work of the Packers and Stockyards Administration. A number of illustrations of matters of sufficient importance to warrant special mention are given in this report in order to indicate the results obtained by this method.

### SHORT-WEIGHT BUTTER CARTONS.

For some time complaints had been made that an important packer was engaged in the preparation and marketing of butter, in a certain section of the country, in cartons designed to hold 1 pound each which had been labeled for that purpose but which actually contained only 15 ounces of butter, the labels, in most cases, being merely changed so as to substitute a statement of the contents as being 15 ounces instead of 1 pound previously shown. It was contended by other packers and distributers of butter that this was an unfair and uneconomic practice, but that, if permitted, the complaining parties must do likewise in order to maintain their trade. Upon receiving the complaints, the Packers and Stockyards Administration took up the question informally with the national organization of the meat packers, with the result that a committee was appointed consisting of representatives of the parties immediately concerned, together with other representatives of the industry and of a national organization of creamery-butter manufacturers. The question was presented to this committee on the basis of its practical business and economic aspects and resulted in the unanimous conclusion and recommendation by the committee that the practice should be discontinued, together with an indorsement of the principle of standard containers. Specifically, the committee recommended for butter that the contents of retail cartons be on the basis of pounds and half and quarter pounds. The recommendations of this committee were indorsed by the two national organizations referred to and immediately put into effect by the packer against whom complaint had been lodged. Thus all formal proceedings were rendered unnecessary. As sales of butter in such short-weight cartons were said to have been in very considerable quantities, it is believed that not only was a desirable principle established but that consumers of butter were afforded an immediate and substantial benefit in the section where the short-weight cartons had been sold.

### DISCRIMINATION IN BUTTER-FAT BUYING AT COUNTRY POINTS.

A different type of complaint with respect to the operations of packers involves the charge of unfair discrimination in the purchase by certain packers at country points of butter fat for manufacture into butter, it being charged, in some cases, that a packer, through financial power or otherwise, has driven competitors out of business by bidding up the prices of butter fat during periods of competition and then, when the competitors have been driven out, lowering prices to recoup. Such complaints disclose serious questions as to the extent to which competitive methods may be indulged in without becoming unfair or unlawful. In one case, the investigation of which was completed before the close of the fiscal year, the complaint was found to be unjustified and the complainant has been notified accordingly.

### PRICES OF REACTOR CATTLE.

When the tuberculin test is applied to apparently healthy cattle they sometimes react, showing the presence of tuberculosis otherwise unsuspected. Such animals are usually sent to market for sale and slaughter. It was found that even in large stockyard markets where there was considerable competition otherwise arbitrary discounts were being applied in the purchase of such animals merely because they were "reactors," without regard to the actual grade and quality of their carcasses. This apparently unjust discrimination has been taken up by the Bureau of Animal Industry and the Packers and Stockyards Administration with the large packers at these markets, with the result that many thousands of dollars are being added annually to the prices paid for such live stock and the campaign for tuberculosis eradication materially aided.

### SOFT AND OILY HOGS.

The Packers and Stockyards Administration is cooperating with the Bureau of Animal Industry in working out plans for the identification of soft and oily hogs purchased and slaughtered by packers as a means of developing an equitable solution of the problem with which the producers of southern hogs are contending.

### STRING SALES.

The practice known as "string sales," or tying together, which has been followed at many stockyards, and which consists, broadly speaking, in most instances of the sale of live stock belonging to different owners in one transaction at one price, has been carefully investigated by the Packers and Stockyards Administration and the policy determined upon that the practice should be eliminated or safeguards provided in order to prevent unfair advantage being taken of individual owners. The conclusions of the Packers and Stockyards Administration have been announced and are being put into effect by the live-stock market supervisors with the cooperation of the commission men and packer buyers. Nothing in the position of the Packers and Stockyards Administration, however, prevents the cooperative sale of live stock to the best advantage of the owners when the plan has been understood and agreed upon.

### FILLING ORDERS FROM CONSIGNMENTS.

Another practice that was found in existence to a considerable extent in some markets was that on the part of commission men of filling purchase orders received from customers out of live stock consigned to the commission men for sale without placing such consignments of live stock on the open market. The Packers and Stockyards Administration is establishing, through its supervisors, the principle that live stock consigned to commission men for sale at their respective stockyards must be placed on the open market for a reasonable length of time before purchase orders received by the same commission men are filled out of such consignments, and then such purchase orders should be filled at prices equal to or better than those afforded by the open market.

### "MARKING UP."

Another practice, occasionally designated as "marking up," was found, which consists, in substance, of the sale by a commission man of a lot of animals of different grades at one price and then accounting to the shipper according to the various grades at different prices which represent the judgment of the commission man as to the current market values. It was found that abuse was resulting from this practice through its deceptive effect upon the shipper as to the real selling price of his live stock and also through the opportunity it afforded for unfair advertising of the sales results of the commission men involved. Therefore the live-stock market supervisors, under instructions from Washington, are requiring the commission men to show the true sale prices on their accounts sales; but this does not prevent the commission men from performing the prorating service on cooperative shipments when instructed by consignees to do so.

### CALIFORNIA LIVE-STOCK PRICES.

In the State of California considerable complaint has been made that commercial quotations of live-stock prices were inaccurate and misleading, and there being no public stockyard markets in that State, the Packers and Stockyards Administration is cooperating with the Bureau of Markets and Crop Estimates and the State authorities for the purpose of aiding in the development of a governmental market news service that will give authentic information.

### PATRONAGE DIVIDENDS BY COOPERATIVE SELLING AGENCIES.

The packers and stockyards act requires strict adherence to the published schedules of rates and charges of commission agencies and does not permit rebating, but provides that the distribution on a patronage basis of excess earnings of cooperative associations among their bona fide members on their live stock does not constitute a violation of these requirements. However, in some of the plans of cooperative organizations, provision was made for the payment of patronage dividends to anyone who might utilize the services of the cooperative associations for marketing his products without regard to whether he was a member or not. This question has been taken up informally with each of the associations involved, with the result that they are now confining their plans for the payment of patronage dividends exclusively to bona fide members. This does not prevent them from doing business with nonmembers and adding the surplus earnings derived therefrom to their dividends, provided they make no refunds or deductions from the scheduled rates and charges to the nonmembers.

Numerous other matters involving special handling, such as questions of proper assignment of pens to the various agencies in stockyards, better railroad service, the inhumane handling and injury of live stock through the use of clubs and other improper implements, disputes arising out of the mixing of live stock in the yards, wholesome feed and proper feed charges, and the like, have been disposed of locally by live-stock market supervisors without formal action.

It is the aim of the Packers and Stockyards Administration to develop as far as possible the disposition on the part of local agencies to adopt proper rules and standards of conduct and to enforce them without interference or compulsion by the Government. For example, the commission men in one of the important markets where there is no exchange very early appealed to the Packers and Stockyards Administration to establish rules in that market which would prevent certain practices that were looked upon as wasteful and to some extent unfairly competitive, but which the commission men had not previously felt able to stop. It was pointed out to them that the packers and stockyards act expressly requires the market agencies to adopt and enforce reasonable rules and regulations of their own, which, upon being published and filed with the Government, must be observed, and that they could handle many matters effectively from a local standpoint. As a result they formulated a number of rules in conference with the local supervisor. These rules have been published and filed and are being observed to the general satisfaction of the agencies concerned.

## FORMAL PROCEEDINGS.

Whenever after a complaint is filed the stage is reached where it does not seem possible to accomplish a satisfactory adjustment informally, the proceeding is given a place on the formal docket of the Packers and Stockyards Administration. Prior to June 30 there had been instituted eight such proceedings, and each will be described in this report under its caption and docket number.

*Docket No. 1.*—Kansas City Live Stock Exchange, complainant, *v.* Armour & Co. and Fowler Packing Co., respondents. The Kansas Live Stock Association, The Missouri Live Stock Producers' Association, The National Live Stock Producers Association, Missouri Farmers' Association, and Farmers Union of Kansas, interveners.

This was a complaint filed by the Kansas City Live Stock Exchange, which is composed of commission men in the Kansas City market, against Armour & Co. and the Fowler Packing Co., with respect to the operation by the Fowler Packing Co. of its yards, known as the Mistletoe Stock Yards, at Kansas City, Kans., a short distance from the Kansas City public stockyards. The Fowler Packing Co. is owned by Armour & Co. It was complained that the Mistletoe Stock Yards were really a public stockyard market within the meaning of Title III of the packers and stockyards act and should be so determined by the Secretary of Agriculture. It was also complained that the methods of doing business in these yards were contrary to Title III relating to stockyards and to Title II relating to packers under the packers and stockyards act because of alleged unfair, unjustly discriminatory, and deceptive practices, and further because the buying operations of the two respondent concerns were alleged to affect adversely the interests of producers and shippers who patronize the Kansas City public stockyards by depressing the prices in that market. A formal hearing was held at Kansas City, Mo., beginning March 27, 1922, and lasting 12 days, before an examiner of the Packers and Stockyards Administration. The various associations named as interveners participated in the hearing for the purpose of assisting in having the facts developed completely. Following the hearing, proposed findings of fact and briefs were submitted by the parties and tentative findings of fact were prepared and submitted to the parties by the examiner. The proceeding was pending consideration of these findings of fact on June 30.

*Docket No. 2.*—The Secretary of Agriculture *v.* Stewart-Carson-McCormack Co. and others, National Stock Yards, Ill.

Very soon after the posting on November 1 of the stockyards at East St. Louis, Ill., it developed that there were certain commission agencies in that market, including two cooperative selling agencies, that were not members of the St. Louis Live Stock Exchange, and it was complained by these independent selling agencies that they were being subjected to a boycott by the entire membership of the live-stock exchange and by practically all the traders and order buyers in that market. Repeated and persistent efforts to secure an amicable adjustment of the matter between the parties failed, and, therefore, a formal complaint was issued, the principal charge of which was unfair and unjustly discriminatory practices through a boycott by the respondents. The hearing was set for April 3, before an examiner of the Packers and Stockyards Administration, and was entered upon, but it appeared that a satisfactory adjustment could be reached by common agreement of all concerned, and this was actually worked out, resulting in the issuance of an order, accepted by all parties, directed to the respondents to cease and desist from the continuance of the boycott, and business was immediately resumed on an open-market basis. The St. Louis Live Stock Exchange amended its rules to conform to the requirements of the order, and since then several of the other leading exchanges have amended their rules voluntarily in a similar way.

*Docket No. 3.*—The Secretary of Agriculture *v.* W. E. Hilton and others, National Stock Yards, Ill.

This complaint pertained to an advance by the Order Buyers' Association in commission charges for buying hogs at National Stock Yards, Ill., on eastern orders from packers. As the result of a resolution passed by the association, commission charges were raised from $3 per single deck and $5 per double deck to $10 per car whether single or double deck. Provision was made also that all exchange on drafts must be paid by the purchaser. It appeared that the proposed charges were not wholly just and reasonable and a revised schedule offered by the association subsequent to the issuance of the Secretary's complaint, fixing a rate of $6 per single deck and $10 per double deck, together with the requirement that all exchange on drafts be paid by the purchaser, was substituted after a hearing and consideration of all the facts including rates for similar services in other markets.

*Docket No. 4.*—The Secretary of Agriculture *v.* The Belt Railroad & Stockyards Co., Indianapolis, Ind.

On March 10, 1922, the Belt Railroad & Stockyards Co. of Indianapolis, Ind., announced an increase in the price of corn from $1.10 to $1.30 per bushel. This advance appeared unreasonable on its face and the tariff was suspended by the Secretary. Prior to the date set for hearing the stockyards company canceled the proposed advance and restored the price to $1.10 per bushel, pending an informal investigation and audit by the administration of its feed records. The complaint was then dismissed.

*Docket No. 5.*—The Secretary of Agriculture *v.* The Peoria Union Stock Yards Co., Peoria, Ill.

*Docket No. 6.*—The Secretary of Agriculture, *v.* Union Stockyards Co. of Omaha, Ltd., South Omaha, Nebr.

*Docket No. 7.*—The Secretary of Agriculture *v.* Union Stockyards & Transit Co., Chicago, Ill.

Following the assumption of jurisdiction by the Secretary of Agriculture at the stockyards at Peoria, Ill., South Omaha, Nebr., and Chicago, Ill., it appeared that a new charge not previously imposed was being exacted by the stockyards companies from traders on account of the reweighing of live stock necessitated by their transactions. The major portion of the revenues of the stockyards companies are derived from the yardage charges assessed against live stock in the hands of commission men and from the feeding of live stock in the yards. The traders complained that the new charge was unfairly discriminatory and excessive. Its consideration involved the consideration of other charges of the stockyards companies in case it was found that any readjustment of charges should be made in order to satisfy the complaints. The stockyards companies insisted upon the propriety of the new charges and the justice of their contentions, and accordingly it was necessary to issue formal complaints. The hearings upon these complaints were set for dates in June, but in order to meet the wishes of various parties interested have been postponed until September, 1922.

*Docket No. 8.*—The Secretary of Agriculture *v.* Eidson, Hopkins Co., and others, Baltimore, Md.

The complaint in this proceeding was issued as a result of the receipt of complaints from shippers who protested against a proposed schedule of charges of the Baltimore Live Stock Exchange, whereby there would be exacted, in addition to the regular commission charge, 50 cents for each additional account sales after the first two on cooperative live-stock shipments handled by exchange members. This charge on its face appeared to be excessive compared with the value of the service rendered, and the tariff was suspended. Formal hearing has been set for August 17. A general inquiry in connection with this proceeding will be made into the basis for the various rates and charges made by members of the Baltimore exchange.

# REPORT OF THE SOLICITOR.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SOLICITOR,
*Washington, D. C., September 8, 1922.*

SIR: I submit herewith report of the work of the office of the solicitor for the fiscal year ended June 30, 1922.

Respectfully,

R. W. WILLIAMS,
*Solicitor.*

Hon. HENRY C. WALLACE,
*Secretary of Agriculture.*

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Pursuing the policy adopted in the submission of the last annual report of this office, details of the work of the office for the fiscal year ended June 30, 1922, are omitted.

The last annual report contains a list of the principal regulatory statutes committed to this department for administration. Since then the so-called future trading act, the packers and stockyards act, 1921, the Capper-Volstead Cooperative Marketing Act, and the Federal highway act were passed, each providing for their administration by you. The future trading act was declared unconstitutional by the Supreme Court of the United States as to its regulatory provisions. The Supreme Court upheld the constitutionality of the packers and stockyards act in suits brought by Chicago live-stock commission men and traders.

I am pleased to report the reduction of the office force during the year by three—one lawyer and two clerks.

The principal work of the office consists in the giving of legal advice to the Secretary and to the administrative heads of the several bureaus, offices, divisions, and boards in the department and to such of the general public as may request information upon subjects covered by the various statutes administered by the department; preparation of cases, both civil and criminal, under the various regulatory statutes administered by the department, for reference to the Attorney General; assistance to United States attorneys in the conduct of the department's litigation in the courts; drafting and reporting upon proposed congressional legislation affecting the work of the department; preparation or revision of the regulations and orders of the Secretary of Agriculture promulgated under the various regulatory laws; preparation of contracts and similar documents; and prosecution of applications for patents on inventions by department employees.

The following is a summary of the work of the office during the year, so far as it is possible to present it statistically:

There were reported to the Department of Justice 4,864 violations of statutes intrusted to the department for enforcement. The following table shows the several statutes under which these violations were reported and the amounts of fines and recoveries in cases settled with and without contest:

*Cases reported, fines imposed, and judgments recovered.*

| Law involved. | Number of cases. | Fines and recoveries. |
|---|---|---|
| National forest laws | 1,032 | $45,056.95 |
| Twenty-eight hour law | 1,245 | 70,225.00 |
| Food and drugs act | 1,411 | 20,745.00 |
| Animal quarantine laws | 122 | 16,905.00 |
| Migratory-bird treaty act | 737 | 8,825.01 |
| Insecticide act | 99 | 2,600.00 |
| Meat inspection act | 93 | 1,190.00 |
| Lacey Act | 13 | 660.00 |
| Pisgah game preserve | 13 | 345.00 |
| National forest game regulations | 30 | 970.40 |
| Bird reservation trespass law | 4 | 25.00 |
| Plant quarantine act | 63 | 1,202.00 |
| Virus-serum-toxin act | 2 | 20.00 |
| Total | 4,864 | 168,769.36 |

Six hundred and fifty-three formal written opinions were rendered the administrative officials of the department. No record was preserved of advice given these officials in daily informal conferences.

Contracts and leases were prepared or examined as follows:

*Contracts and leases prepared or examined.*

| Bureau, division, or office. | Contracts. | Leases. | Total. |
|---|---|---|---|
| Forest Service | 1,275 | 7 | 1,282 |
| Bureau of Animal Industry | 1 | 25 | 26 |
| Biological Survey | 1 | 2 | 3 |
| Bureau of Chemistry | 4 | 3 | 7 |
| Chief Clerk | 4 | 7 | 11 |
| Bureau of Entomology | 4 | 39 | 43 |
| Bureau of Markets and Crop Estimates | 3 | 43 | 46 |
| Federal Horticultural Board | 5 | 5 | 10 |
| Office of Exhibits | 1 | 1 | 2 |
| Insecticide and Fungicide Board | 3 | 1 | 4 |
| Mechanical Shops | 1 | .......... | 1 |
| Packers and Stockyards Administration | .......... | 18 | 18 |
| Bureau of Plant Industry | 12 | 18 | 30 |
| Bureau of Public Roads | 1,572 | 26 | 1,598 |
| Division of Publications | 1 | 1 | 2 |
| Weather Bureau | 6 | 25 | 31 |
| Total | 2,893 | 221 | 3,114 |

During the year 49 bonds, 353 renewals, and 29 terminations of leases and contracts were prepared.

Twenty-seven applications for letters patent on inventions of employees of the department were prepared and filed. Of these and those pending at the close of the preceding fiscal year eight were allowed and six disallowed.

Thirty-one claims for balances due estates of employees of the department who died intestate were examined, the necessary papers prepared for their payment, and advice furnished administrative officers of the department relative to the same.

In the distribution of the $1,500,000 appropriated by Congress to enable farmers in the drought-stricken regions of the Northwest to purchase grain seed for the 1922 planting, one of the lawyers of the office was detailed to Grand Forks, N. Dak., to assist the administrative officials of the department in handling the loans and mortgages taken to secure them. Approximately 15,000 applications for loans were received and 12,125 loans were made. The legal forms necessary to effect these loans were prepared in this office.

## COLLECTION AND DISTRIBUTION OF EXCESS PROFITS ON WOOL CLIP OF 1918.

The department has met with stubborn opposition in the collection of the 1918 wool-clip excess profits in a number of cases and it has been necessary to institute suits to collect these profits. Preliminary to the institution of the suits this office prepared a very exhaustive memorandum on the legal authority of the War Industries Board to prescribe and enforce the wool regulations of 1918 and furnished this to the Department of Justice and the various United States attorneys to whom cases were referred. In addition to this, the office prepared the complaints or declarations to be filed in the cases and assistance was rendered the United States attorneys in further proceedings in this litigation. In two cases the office participated in the oral arguments in the courts. In the only three contested cases in which decisions have been rendered the Government prevailed.

## KANSAS CLAIMS.

Following the outbreak of cattle-fever ticks in certain portions of Kansas in 1919, caused by the shipment into Kansas from Texas of ticky cattle, pursuant to certificates issued by an inspector of this department, a bill was introduced in Congress for the relief of a number of Kansas cattle raisers who were affected by the outbreak. The bill was referred to you for a report and this office exhaustively examined the various claims, calling for additional evidence when necessary, and prepared a full report upon which your recommendation was made to the Senate Committee on Claims. Numerous conferences were had during the consideration of these claims with the live-stock commissioner of Kansas and Members of Congress.

## ALLEGED VIOLATIONS BY DEPARTMENT EMPLOYEES OF TRAFFIC REGULATIONS.

A number of department employees were arrested during the year for alleged violations of the District of Columbia traffic regulations. These employees were represented at the trials and hearings by lawyers in this office.

## CONFERENCES WITH MANUFACTURERS AND PRODUCERS OF FOODS AND DRUGS, AND THEIR ATTORNEYS.

A number of manufacturers and producers of foods and drugs and their attorneys conferred with this office during the year with reference to cases pending in the courts and the character of labels and advertisements used or proposed to be used by them.

### THE NATIONAL FORESTS.

Three hundred and seventy claims to lands in the national forests, founded upon the homestead, mineral, railroad grant, lieu selection, and other general and special laws were handled. One hundred and ten decisions were rendered by the Interior Department, 48 in favor of the Government and 62 adverse. Decisions in favor of the Government resulted in the retention in the national forests of lands supporting approximately 99,000,000 feet of timber, worth approximately $280,000.

*Trespass cases on the national forests.*

| Character of trespass. | Number. | Damages. | Fines. |
|---|---|---|---|
| Grazing | 341 | $28,250.97 | $675.00 |
| Timber | 36 | 2,684.30 | .......... |
| Fire | 613 | 8,143.26 | 4,785.72 |
| Property | 15 | 460.00 | .......... |
| Occupancy | 27 | 57.70 | .......... |
| Total | .......... | 39,596.23 | 5,460.72 |

*Operations under the Weeks forestry law during the fiscal year 1922.*

| State. | Titles examined to acreage acquired, 1922. | Titles examined to acreage in condemnation. | Titles examined to acreage purchase of which not completed. |
|---|---|---|---|
| | *Acres.* | *Acres.* | *Acres.* |
| Alabama | 16,947 | 9,058 | 3,350 |
| Arkansas | 16,674 | 3,736 | 7,314 |
| Georgia | 10,573 | 3,658 | 74 |
| Maine | 22 | 0 | 0 |
| New Hampshire | 21,238 | 1,459 | 0 |
| North Carolina | 21,405 | 4,361 | 890 |
| Pennsylvania | 0 | 0 | 0 |
| South Carolina | 0 | 0 | 0 |
| Tennessee | 31,826 | 2,616 | 7,515 |
| Virginia | 15,578 | 16,405 | 50,395 |
| West Virginia | 4,349 | 420 | 24,164 |
| Total | 138,612 | 41,713 | 93,702 |

There were prepared 326 agreements for purchase of lands authorized to be acquired by the National Forest Reservation Commission.

### FEDERAL AID ROAD ACTS.

Project statements for 1,245 projects were reviewed during the year to determine whether the projects were eligible for Federal aid. Of these projects 1,237 were approved and 8 disapproved. The 1,237 projects which were approved involved a total estimated expenditure of $101,568,047, Federal aid in the amount of $48,084,965. and 3,137.6 miles of road.

During the fiscal year project agreements and certificates of approval of plans, specifications, and estimates, prepared by the Bureau of Public Roads, for 912 projects were reviewed as to their legal form and sufficiency before being transmitted to the State highway department for execution. These project agreements, such as were not examined and submitted to the Secretary for signature in advance of execution by the State highway departments, were subsequently examined as to the sufficiency of their execution by the State highway departments and were submitted to the Secretary and executed by him. In all they involved 5,779.4 miles of road and a total estimated expenditure of $99,331,404, Federal aid aggregating $42,504,875.

Drafts of 545 modifications and 55 cancellations of project agreements and certificates, prepared by the Bureau of Public Roads and executed by the State highway departments and the Secretary, were similarly reviewed.

In addition to the above, there were reviewed as to legal form and substance 25 original agreements for the construction of roads within or partly within the national forests, under the provisions of section 23 of the Federal highway act.

In accordance with section 10 of the Federal highway act, certificates were submitted by the governors of 46 States and, in considering these certificates for the purpose of determining whether proper showing was made that the laws of the States permitted compliance with the requirements of the act, it was necessary to review carefully the highway laws to determine whether approval by the Secretary could properly be given. Of the certificates submitted for the 46 States, 36 were forwarded to the Secretary for his approval. The certificates submitted by the 10 other States, when considered in conjunction with the State statutes, were regarded as not fully complying with the terms of the Federal highway act, but inasmuch as they complied therewith in so far as the laws of the respective States permitted, recommendations were made in accordance with section 24 of the Federal highway act that these States continue to have their projects approved for a period of five years from November 9, 1921, in accordance with the provisions of said section 24 as amended by paragraph 5 of section 4 of the act of June 19, 1922 (Public, No. 244).

## FOOD AND DRUGS ACT.

Thirteen hundred and ninety-four cases under the food and drug act were reported to the Department of Justice, 262 for criminal prosecutions and 1,132 for seizures.

*Fines imposed in criminal cases.*

| Number of cases. | Fines. | Total. | Number of cases. | Fines. | Total. |
|---|---|---|---|---|---|
| 4 | $1 | $4 | 1 | $101 | $101 |
| 17 | 5 | 85 | 8 | 150 | 1,200 |
| 30 | 10 | 300 | 6 | 200 | 1,200 |
| 5 | 15 | 75 | 1 | 225 | 225 |
| 22 | 20 | 440 | 3 | 250 | 750 |
| 66 | 25 | 1,650 | 3 | 300 | 900 |
| 4 | 30 | 120 | 2 | 400 | 800 |
| 1 | 35 | 35 | 2 | 500 | 1,000 |
| 1 | 40 | 40 | 1 | 800 | 800 |
| 84 | 50 | 4,200 | 1 | 2,000 | 2,000 |
| 2 | 60 | 120 | 2 | Costs. | ...... |
| 9 | 75 | 675 | | | |
| 36 | 100 | 3,600 | 311 | | 20,320 |

Of the 1,249 civil cases terminated during the year, decrees of condemnation and forfeiture or informal orders for the disposition of the property were entered in 1,149. In 30 cases the libels were dismissed;

in 58 the packages were broken or disposed of before seizure could be made, or were destroyed by city or State officials or voluntarily by the owner before seizure; in 6, verdicts were returned for the Government after trial and in one a verdict for the claimant. In two cases the goods were released to the claimant without a decree, and in one the goods were destroyed without decree. In two of the cases that were tried a verdict for the Government was returned on the misbranding charge and for the claimant on the adulteration charge. In the 1,149 cases in which decrees of condemnation and forfeiture were entered the goods were destroyed in 762, released on bond or otherwise in 296, sold in 49; in 23 cases the marshal was instructed to sell the goods or destroy them at his discretion; in 17 cases, the goods forfeited being wholesome, were delivered to charitable institutions; in 2 cases the goods were delivered to fish hatcheries for fish food.

*Fines imposed in food and drug cases begun by United States attorneys on reports of State authorities.*

| Number of cases. | Amount of fines or collateral. | Total. |
|---|---|---|
| 9 | $25 | $225 |
| 2 | 50 | 100 |
| 1 | 100 | 100 |
| 12 | | 425 |

One thousand one hundred and fifty notices of judgment were prepared and published during the year.

## THE INSECTICIDE ACT.

Ninety-nine cases were reported to the Department of Justice, 68 for criminal prosecutions and 31 for seizures. Seventy-six cases pending at the close of the preceding fiscal year and 53 cases reported during this fiscal year, in all 129 cases, were terminated during the year. Of the cases terminated, 84 were criminal and 45 were civil. Fines were imposed in 72 criminal cases and 12 were dropped or dismissed. Pleas of "guilty" were entered in 59 cases, pleas of nolo contendere were entered in 9, and verdicts of "guilty" were rendered in 4. Decrees of condemnation and forfeiture were entered in 40 cases.

*Fines imposed under the insecticide act.*

| Number of cases. | Amount of fine. | Total. |
|---|---|---|
| 5 | $5.00 | $25.00 |
| 14 | 10.00 | 140.00 |
| 2 | 12.50 | 25.00 |
| 2 | 7.50 | 15.00 |
| 3 | 15.00 | 45.00 |
| 2 | 20.00 | 40.00 |
| 13 | 25.00 | 325.00 |
| 5 | 30.00 | 150.00 |
| 1 | 40.00 | 40.00 |
| 16 | $50.00 | $800.00 |
| 2 | 60.00 | 120.00 |
| 3 | 75.00 | 225.00 |
| 1 | 100.00 | 100.00 |
| 1 | 150.00 | 150.00 |
| 2 | 200.00 | 400.00 |
| 72 | ............ | 2,600.00 |

One hundred notices of judgment were prepared and published.

## THE MIGRATORY-BIRD TREATY ACT.

Seven hundred and thirty-seven cases were reported to the Department of Justice.

*Fines imposed under the migratory-bird treaty act.*

| Number of cases. | Amount of fine. | Total. |
|---|---|---|
| 1 | $0.01 | $0.01 |
| 49 | 1.00 | 49.00 |
| 3 | 2.00 | 6.00 |
| 5 | 2.50 | 12.50 |
| 5 | 3.00 | 15.00 |
| 76 | 5.00 | 380.00 |
| 197 | 10.00 | 1,970.00 |
| 1 | 12.50 | 12.50 |
| 12 | 15.00 | 180.00 |
| 50 | 20.00 | 1,000.00 |
| 89 | $25.00 | $2,225.00 |
| 12 | 35.00 | 420.00 |
| 2 | 40.00 | 80.00 |
| 24 | 50.00 | 1,200.00 |
| 1 | 75.00 | 75.00 |
| 10 | 100.00 | 1,000.00 |
| 1 | 200.00 | 200.00 |
| 538 | ............ | 8,825.01 |

In several cases, defendants were sentenced to jail for terms ranging from three days to three months.

## THE LACEY ACT.

Thirteen cases were reported to the Department of Justice.

*Fines imposed under the Lacey Act.*

| Number of cases. | Amount of fine. | Total. |
|---|---|---|
| 4 | $5 | $20 |
| 1 | 6 | 6 |
| 3 | 10 | 30 |
| 1 | 20 | 20 |
| 5 | 25 | 125 |
| 1 | 26 | 26 |
| 1 | 30 | 30 |
| 1 | $45 | $45 |
| 1 | 50 | 50 |
| 1 | 88 | 88 |
| 1 | 100 | 100 |
| 1 | 120 | 120 |
| 21 | ............ | 660 |

## BIRD RESERVATION TRESPASS LAW.

Four cases were reported to the Department of Justice. During the year three cases were terminated, all by convictions and the imposition of fines aggregating $25.

## PISGAH GAME PRESERVE LAW.

Thirteen cases were reported to the Department of Justice. During the year 14 cases were terminated, 8 by convictions and the imposition of fines, 1 by dismissal, and 5 by entering orders of nolle prosequi.

*Fines imposed under the Pisgah Game Preserve Law.*

| Number of cases. | Amount of fine. | Total. |
|---|---|---|
| 1 | $20 | $20 |
| 4 | 25 | 100 |
| 1 | 50 | 50 |
| 1 | 75 | 75 |
| 1 | 100 | 100 |
| 8 | ............ | $345 |

## NATIONAL FOREST GAME REGULATIONS.

Thirty cases were reported to the Department of Justice and all were terminated by convictions and the imposition of fines aggregating $970.40.

## TWENTY-EIGHT HOUR LAW.

One thousand two hundred and forty-five violations of the 28-hour law were reported to the Department of Justice.

Penalties collected during the year amounted to $70,225.

## MEAT-INSPECTION LAW.

Ninety-three violations of the meat-inspection law were reported to the Department of Justice.

*Fines imposed under the meat-inspection law.*

| Number of cases. | Fines. | Total. | Number of cases. | Fines. | Total. |
|---|---|---|---|---|---|
| 1 | $100 | $100 | 1 | $15 | $15 |
| 11 | 50 | 550 | 4 | 10 | 40 |
| 3 | 35 | 105 | 1 | 5 | 5 |
| [1]9 | 250 | 250 | | | |
| 5 | 25 | 125 | 35 | ............ | 1,190 |

[1] Lump fine.

## VIRUS-SERUM-TOXIN ACT.

Two violations were reported to the Attorney General for prosecution under this act. One of these was terminated by the imposition of a fine of $10 against each of two defendants.

## ACTS REGULATING INTERSTATE MOVEMENT OF LIVE STOCK FROM QUARANTINED DISTRICTS, PROHIBITING INTERSTATE MOVEMENT OF DISEASED LIVE STOCK, AND PROHIBITING IMPORTATION OF DISEASED LIVE STOCK.

One hundred and twenty-two cases under the animal quarantine laws were reported to the Department of Justice.

*Fines imposed under animal quarantine laws.*

| Number of cases. | Fines. | Total. | Number of cases. | Fines. | Total. |
|---|---|---|---|---|---|
| 2 | $5 | $10 | 1 | $200 | $200 |
| 2 | 10 | 20 | 8 | 150 | 1,200 |
| 4 | 25 | 100 | 141 | 100 | 14,100 |
| 13 | 50 | 650 | | | |
| 5 | 75 | 375 | 177 | ............ | 16,905 |
| 1 | 250 | 250 | | | |

## PLANT QUARANTINE ACT.

Sixty-three cases under the plant quarantine act were reported to the Department of Justice.

*Fines imposed under plant quarantine act.*

| Number of cases. | Fines. | Total. | Number of cases. | Fines. | Total. |
|---|---|---|---|---|---|
| 1 | $1 | $1 | 3 | $50 | $150 |
| 3 | 5 | 15 | 1 | 70 | 70 |
| 5 | 10 | 50 | 1 | 80 | 80 |
| 1 | 15 | 15 | 5 | 100 | 500 |
| 1 | 20 | 20 | 1 | 140 | 140 |
| 5 | 25 | 125 | | | |
| 1 | 36 | 36 | 28 | ............ | 1,202 |

## FUTURE TRADING ACT.

Prior to the decision of the Supreme Court declaring unconstitutional the regulatory features of the future trading act, this office assisted the officer in charge of the administration of the future trading act in preparing necessary forms required for administration of the act and amendments of board of trade and exchange rules to meet the requirements of the act. Assistance was rendered the United States Attorney at Chicago in the conduct of the injunction suit which finally went to the Supreme Court, and aid was rendered the Solicitor General in the preparation of the Government's brief in the Supreme Court.

## UNITED STATES WAREHOUSE ACT.

Assistance was given the Bureau of Markets and Crop Estimates in the preparation of numerous forms to be used in administering the act. The office reviewed for legal sufficiency 300 warehouse bonds.

## UNITED STATES GRAIN STANDARDS ACT.

Assistance was given the Bureau of Markets and Crop Estimates in the preparation of regulations and forms under this act and in the drafting of notices of hearings on charges under section 5 of the act. Evidence introduced at nine hearings was considered and findings of fact prepared for your consideration.

## CENTER MARKET ACT.

Rules and regulations for the operation of Center Market in Washington, placed under your administration by the act of March 4, 1921, were prepared in cooperation with the administrative officers. Forms of permits, contracts, leases, and warehouse receipts for use in the administration of the market were prepared and legal advice was given the administrative officers on questions which have arisen from time to time in connection with the operation of the market.

## COTTON FUTURES ACT.

Assistance in drafting amendments to, and finally a proposed complete revision of, the regulations under the act were given the administrative officers. Proof of a claim due the department for services rendered in classifying cotton under the act was prepared for filing in the bankruptcy proceedings pending against the firm of Shepard & Gluck, of New Orleans.

## FOOD PRODUCTS INSPECTION LAW.

The provision authorizing a food products inspection service, which for several years has been carried in the annual appropriation acts for the department, was enlarged somewhat by the appropriation act of May 11, 1922, making appropriations for the fiscal year 1923, in that inspections were authorized at shipping points as well as at important central markets designated by the Secretary and points which can be conveniently reached therefrom. Advice on questions arising under this provision was given the administrative officers, and, in cooperation with them, there were drafted suitable regulations for carrying on the work, forms for licensing as inspectors persons who are not employees of the department, and forms of certificates.

In cooperation with the administrative officers, a bill was drafted at the request of a Member of Congress to authorize the Secretary to establish and recommend approved trading rules and business practices for handlers of and dealers in farm products, to provide for a system of adjustment of disputes, and for other purposes. A bill (H. R. 9952) which was introduced in Congress along this line was examined and amendments thereto were suggested.

## CAPPER-VOLSTEAD ACT.

A statement relative to this act was prepared in cooperation with administrative officers and assistance was given them in the preparation of answers to inquiries regarding the scope and operation of the act.

## PACKERS AND STOCKYARDS ACT.

Assistance was rendered to and conferences had with your assistant in charge of the Packers and Stockyards Administration and its attorney with reference to several matters arising under the packers and stockyards act.

## FEDERAL WATER-POWER ACT.

A number of opinions, prepared by the chief counsel of the Federal Power Commission on legal questions arising in the administration of the Federal water-power act submitted to this department for consideration, were carefully examined by this office and returned with appropriate comment. Consideration was also given to regulations proposed for carrying out the act.

## MISCELLANY.

A number of cases involving the personnel of the department were considered during the year and advice given with reference thereto.

A great many letters and other papers prepared for your signature or approval in the various bureaus of the department, referred to this office for consideration, were passed upon and frequently modified, amended, or rewritten.

Conferences with representatives of the other departments with reference to a policy to regulate applications for patents on inventions by Government employees and to standardize the contract forms to be used by the Government were attended by representatives of this office.

Among a number of interesting decisions of the courts during the year, I think it is worth while to mention that of the United States District Court for the Northern District of Georgia, in the case of United States *v.* M. J. Gurley and others, which was a bill in equity filed by the Government to restrain the defendants from driving or permitting their cattle to be driven on the Cherokee National Forest in that State, in violation of the regulations of this department. The defendants vigorously contested the right of the Government to forbid the pasturing of cattle on the National Forest unless it should comply with the law of Georgia, which requires owners of land to fence those lands against live stock. In cooperation with the United States attorney, I argued the case for the Government. On February 28 last, the court sustained the Government's contentions, granting the injunction prayed for, and holding that the fence laws of Georgia could not be enforced against the United States. The case is reported in 279 Fed. 874.

Another case of considerable importance and of far-reaching effect was that of United States *v.* Lumpkin, also in the Northern District of Georgia, involving a violation of the migratory-bird treaty act in the shooting of mourning doves during the closed season prescribed by your regulations. The defendant contended that the mourning doves shot by him were resident throughout the year in Georgia and that, therefore, his shooting of the doves could not be made an offense against the United States. The case was tried by a jury and much testimony was introduced by the defendant in an attempt to establish that the mourning doves he shot were resident throughout the year in Georgia. The Government introduced testimony showing that the mourning dove, as a specie, is a migratory bird throughout its range, and contended that even though it could be proved that the mourning doves shot by the defendant were resident in Georgia it still would be no defense. The court sustained the Government's contention in the decision reported in 276 Fed. 580; Department of Agriculture Circular 202. In cooperation with the United States attorney, I conducted the prosecution and the argument in this case.

The revised compilation of the laws applicable to the Department of Agriculture which has been in preparation for some months past was nearing completion at the end of the year, and it is expected that it will be ready for the printer by the middle of September.

The work of the office, considering its nature, is current.

# REPORT OF THE INSECTICIDE AND FUNGICIDE BOARD.

United States Department of Agriculture,
Insecticide and Fungicide Board,
*Washington, D. C., September 9, 1922.*

Sir: I have the honor to submit herewith the report of the work of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1922.

Respectfully,

J. K. Haywood,
*Chairman.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

The insecticide act of 1910 was designed to prevent the manufacture, sale, or transportation of insecticides or fungicides (including disinfectants) which are adulterated or misbranded in any particular. This includes articles which are not of the composition claimed, those which will not accomplish the results promised, and those which are injurious to vegetation when used as directed. The Insecticide and Fungicide Board was created by the Secretary of Agriculture to administer the provisions of this act.

The use of these materials has grown to large proportions, with a consequent increase in the importance of supervision. The industry is rapidly recovering from the depression of 1920–21 and is in a position to make important progress, as protection against insects and diseases is everywhere recognized as an economic necessity, and is a part of the regular routine of commercial farming and fruit growing. It is also regarded by the live-stock industry as an essential part of its operations.

New preparations are constantly being encountered and new uses for established remedies are being developed, so that the regulatory work is all the while increasing and ramifying over the whole field of insect and disease control. When it is considered how many hundreds of insects and diseases are prevalent throughout the United States and how many different remedies are manufactured to control many of these, the possibilities of this work may be imagined, and the board's problem of coping with this situation in an economical yet practical manner can be realized. The situation can only be gradually handled, since to attempt the concurrent and simultaneous inspection and test of all the remedies offered for sale would be a stupendous task and involve a huge expenditure of funds.

The board can best serve by first devoting its attention to the more important remedies without, however, entirely overlooking the numerous remedies offered for insects and diseases of secondary importance or those which are less widespread.

The campaign inaugurated in 1919 and continued during 1920 and 1921, involving the inspection of the calcium arsenate used for cotton-boll weevil control, was continued during the fiscal year 1922. Since the composition of this article steadily grew more constant and satisfactory each year it was manufactured, it was hoped that during the fiscal year 1922 the inspection work on calcium arsenate could be greatly reduced or nearly abandoned. Unfortunately, however, preliminary inspection work showed that in a considerable number of large shipments of calcium arsenate there were present a few containers that showed goods of very poor quality, especially goods that contained an excessive amount of water-soluble arsenic oxide and that would therefore prove very injurious to cotton. This situation required the board to devote more attention to the inspection of calcium arsenate than had been contemplated.

One of the chemists of the board developed a simple method of test that could be used by the inspectors to show the presence of an excessive quantity of water-soluble arsenic oxide. This test, while not infallible, resulted in a saving of chemical work and permitted the inspection of many more packages than would have been possible otherwise. It is evident that the inspection of calcium arsenate will have to be continued in a fairly comprehensive way for several more years.

The campaign designed to improve the quality and labeling of Bordeaux mixture and Bordeaux-lead arsenate was continued during the fiscal year 1922, and the labels for most of these preparations were brought into entire conformity with law. Since it was found that Bordeaux mixture was not effective when used as a dust, manufacturers were required to remove the dusting directions from the labels of these products, which, in most cases, was promptly done. Manufacturers were required also to recommend a sufficient dosage to assure effective control of the diseases controllable by Bordeaux. Most of the manufacturers of Bordeaux-lead arsenate, who previously made a product in which the relative proportions of copper and lead arsenate were incorrect, changed their formulas so as to properly balance these constituents. Some few prefer to continue manufacturing under faulty formula, but give directions on the label for adding enough Bordeaux mixture to secure effective fungicidal control and yet not have an excess of lead arsenate. As a whole, therefore, the labels for Bordeaux and Bordeaux-lead arsenate have been greatly improved, although still further work along this line is necessary.

During the fiscal year especial attention was given to some new or hitherto uninspected insecticides and fungicides, particularly proprietary insecticides intended to control the cotton-boll weevil, and combined insecticides and fungicides which were alleged to control many insects and plant diseases, either by inoculation into the tree or by being absorbed by the roots or seeds of the plant.

During the fiscal year 1921 an organized campaign, by seizure and prosecution, was begun against so-called pine-oil disinfectants and so-called coal-tar dips and disinfectants, which, however, were adulterated with mineral oil. This campaign was continued during the fiscal year 1922, with the result that most of the principal offenders either ceased practicing this form of adulteration or so changed their labeling as to correctly describe the article containing the mineral oil. During the campaign 19 seizures were made and prosecution of the manufacturers recommended in 29 cases. Since this practice has not been entirely broken up, but is still being continued by a comparatively few manufacturers or jobbers, the campaign of seizure and prosecution will be continued.

The campaign against adulterated and misbranded disinfectants of various kinds has been continued during the year, with especial reference to pine-oil disinfectants sold for general disinfecting purposes; paradichlorobenzene powders and blocks sold as disinfectants, and new or hitherto uninspected disinfectants the labels of which have flagrantly false and misleading statements. Investigations by the board showed that pine-oil disinfectants were not suited for general disinfecting and that the paradichlorobenzene blocks and powders were not disinfectants. As a result of the campaign, the labels of many of the pine-oil and other disinfectants have been corrected, a number of manufacturers have ceased selling pine-oil disinfectants for general disinfecting purposes, and most of the manufacturers of paradichlorobenzene powders and blocks have removed all disinfectant claims from their labels and literature. Since the practices spoken of above have not been entirely broken up, and since new disinfectants are constantly coming on the market, the labels and literature of which commonly bear false and misleading claims, the campaign to control disinfectants will be continued from year to year.

The campaign started during the fiscal year 1919 against insect powder adulterated with daisy flowers and insect flower stems and, extending through the fiscal years 1920 and 1921, was further continued during the fiscal year 1922. Several seizures of goods adulterated with daisy flowers were made and prosecution recommended of a number of different manufacturers. Some important cases involving this form of adulteration are now pending in the courts and will be vigorously prosecuted. While this form of adulteration has been reduced steadily during the period of this campaign, it does not appear to have been entirely abandoned. Therefore the campaign will be continued.

The campaign against naphthalene nest eggs, recommended to control poultry lice and mites and act as disinfectants, which was begun during the fiscal year 1920, was continued during the fiscal years 1921 and 1922, with the result that all insecticidal and disinfectant claims were removed from the labels and literature of most of the naphthalene nest eggs sold on the American market.

## INTERSTATE SAMPLES.

During the fiscal year the board reported to the Solicitor of the department 89 cases presenting alleged violations of law, with recommendation that the facts be transmitted to the Attorney General to institute criminal action or seizure proceedings. Disposition was made of 153 cases by correspondence with the manufacturers. These cases presented violations which were technical only, not flagrant, or cases in which the manufacturer gave reasonable and adequate explanation of his failure to conform to the provisions of the act.

Action was taken to place in abeyance 582 samples, which upon examination and test were shown to be in compliance with the provisions of the law or were from shipments of the same goods made prior to shipments for which the manufacturer had been convicted and had, after citation, conformed to the requirements of the law. On June 30, 1922, 82 cases were pending preliminary hearings or before the board for final action, 244 were held in temporary abeyance pending the receipt of further information or the outcome of prosecution based on the same product or correspondence with the manufacturers, and 634 samples were undergoing analysis and test.

The inspectors and sample collectors of the board, operating throughout the United States, collected 957 samples during the year. A general classification of the articles represented in the collection is as follows:

*Interstate samples collected.*

| Class of samples. | Number of samples. |
|---|---|
| Arsenate of calcium | 24 |
| Arsenate of lead | 77 |
| Bordeaux mixture and combinations of Bordeaux mixture with insecticides | 62 |
| Chlorinated lime | 10 |
| Dips for animals | 49 |
| Disinfectants, germicides, bactericides | 154 |
| Fly preparations for animals | 36 |
| Fish-oil and whale-oil preparations | 9 |
| Formaldehyde preparations | 8 |
| Insect preparations, household use | 115 |
| Miscellaneous insecticide and fungicide preparations, agricultural use | 88 |
| Kerosene emulsions | 6 |
| Lice and mite killers | 61 |
| Lime-sulphur solution and sulphur preparations | 41 |
| Nicotine preparations | 31 |
| Paris green | 34 |
| Pyrethrum and hellebore powders | 60 |
| Miscellaneous | 92 |

## IMPORT SAMPLES.

During the year 122 official and unofficial import samples of insecticides and fungicides were collected through the various port laboratories of the Bureau of Chemistry for examination and test by the board. Disposition was made of 87 samples; 8 official samples were found adulterated and misbranded, and it was recommended that the consignments be refused entry until correctly labeled. The remaining samples were unofficial, 8 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 70 were neither adulterated nor misbranded. One official sample was found to be neither adulterated nor misbranded and the shipment was released.

## SPECIAL INVESTIGATIONS.

During the fiscal year 1922 the studies of the preparation, composition, and properties of certain arsenates of calcium were continued, as time permitted. It was believed when last year's annual report was written that the work on one paper entitled " The Arsenates of Calcium. II. Equilibrium in the System Arsenic Pentoxide, Calcium Oxide and Water at 35° (Basic Section)" was practically complete. However, when the data were collated and studied it was found that certain further work was necessary, which was continued from time to time during 1922 and will be continued in 1923. This paper covers the region in which there is free lime and practically no arsenic oxide in solution and is consequently of interest to manufacturers of commercial calcium arsenate. It is not known exactly when this paper will be offered for publication, since it has been necessary to drop work on this subject for the present. The work will be resumed at the first opportunity. At about the same time that this paper is offered for publication another paper will also be offered entitled "The Arsenates of Calcium. III. General Preparation and Properties of the Crystallized Salts." The chemical work on this paper, which will describe in detail the preparation and the chemical, optical, and crystallographic properties of about 12 definite calcium arsenates, has been almost completed, but the preparation of the paper will not be attempted until the work on the first paper mentioned in this paragraph is completed.

An investigation was started during the year to determine the active principles of two species of larkspur seeds (*Delphinium consolida* and *Delphinium staphisagria*). This investigation was undertaken largely to determine if the oils in larkspur seeds have any insecticidal value, as claimed by some of the manufacturers of human head and body lice preparations. A digest of the literature has been made and a method of extracting and separating the oils and alkaloids on a considerable scale has been developed. This method is now being applied in obtaining a sufficient amount of oils and alkaloids to make a more detailed study of their chemical composition and their action on insects. Work on this subject will be continued during the fiscal year 1923.

The investigation begun some two years ago to determine what chemical changes commercial samples of calcium arsenate undergo during storage has been completed and the results are in process of publication as a department bulletin under the title "Chemical Changes in Calcium Arsenate During Storage." This work was taken up as a result of the belief by certain manufacturers and users of this product that it deteriorated rapidly and was unfit for use after standing for a few months. The work shows that carbon dioxide is very slowly absorbed by the calcium arsenate (or by the calcium hydrate which is present in commercial calcium arsenate) when kept in certain types of commercial containers, resulting in a gradual increase of water-soluble arsenic, which reaches a maximum after about eight months in the case of the most open containers, such as sugar barrels. Material packed in tight containers, such as metal drums or heavy hardwood barrels, showed practically no change after 20 months' storage. In a few cases, where commercial calcium arsenate was stored in veneer drums and sugar barrels, the deterioration at the end of 20 months was such as to render the material of doubtful safety for application on certain plants having tender foliage.

The study inaugurated some years ago to determine the rate of loss of nicotine in potash-nicotine and soda-nicotine soaps and in papers impregnated with nicotine and to determine the effect of different types of containers on the rate of nicotine loss, the conditions under which loss does and does not occur and the conditions that will prevent loss, was practically completed during the fiscal year 1921, but a little more necessary work was performed during the fiscal year 1922. As soon as time permits the results will be collated and studied and offered for publication, if it appears they are worthy of publication.

A study was started about two years ago in regard to the changes, on storage, of commercial nicotine solution, packed in different types of containers, the effect of light, etc. The results up to date indicate that such solution, when properly packed, deteriorates very slowly. Nicotine dusts made up with the following carriers, talcum, kieselguhr, kaolin, sulphur, calcium sulphate, calcium hydrate, and calcium carbonate, containing 2 to 8 per cent nicotine, show, up to date, very little deterioration after four months, when packed in tight glass jars. When packed in cardboard boxes or bags some loss of nicotine occurs. This loss is greater in the case of lime and calcium-carbonate fillers. This work will be continued during the fiscal year 1922, since it is necessary for the board to have data on this subject, in order that we may be able to handle cases involving shortages in nicotine in nicotine solutions and in nicotine-filler dusts.

It is often necessary to know the possible and probable rates at which samples of chlorinated lime lose available chlorine, in order to be able to successfully prosecute cases based on shortages of available chlorine in commercial samples of chlorinated lime. Therefore, samples of most of the commercial brands of chlorinated lime (bleaching powder) sold on the market were obtained and placed in storage in 1921. Complete analyses were made of these samples when placed in storage and the available chlorine determined monthly thereafter. Valuable data already have been obtained. However, the work will be continued during the fiscal year 1923 on samples of known origin packed under commercial conditions, but under the supervision of board chemists, in order that the complete history of the samples may be known. The data on this subject will be offered later for publication.

On October 1, 1921, United States Department of Agriculture Bulletin No. 989, entitled "Pine Oil and Pine Distillate Product Emulsions: Method of Production, Chemical Properties and Disinfectant Action," was published jointly by the board and the Bureau of Chemistry. This bulletin gives the methods of preparing pine oils and the chemical and physical properties of pine oils and certain other pine by-product oils, all of which is of value in enabling the board to detect adulteration of commercial pine-oil disinfectants. Also the disinfectant action of pine-oil and pine-distillate product emulsions has been studied and valuable scientific data obtained, as well as data which allows the board to pass on the claims on labels of pine-oil disinfectants which are sold on the market.

In March, 1922, a paper was published by one of the board chemists in the Journal of Industrial and Engineering Chemistry, volume 14, page 207, entitled "Errors caused by nitrates and nitrites in the determination of arsenic by the distillation method and a means for their prevention."

During the fiscal year 1922 a considerable number of powders and blocks, composed essentially of paradichlorobenzene, were placed on the market with the claim that they were effective disinfectants. An investigation was therefore made by the bacteriologist of the board of the effectiveness of paradichlorobenzene as a disinfectant. It was found that pure powdered paradichlorobenzene was ineffective against *B. typhosus*, both when used as a fumigant and in the presence of moisture.

In August, 1921, a paper, of which the board microscopist was joint author, was published in the Journal of the American Pharmaceutical Association, under the title "Domestic and imported veratrum (hellebore)."

The plant pathologists of the board have continued investigations with the more important types of fungicides to determine the amount of active ingredients necessary for the control of the various diseases against which they are to be used. The data obtained from these investigations are proving very useful in enabling the board to judge more nearly what can be expected of any product, based on a knowledge of its chemical composition.

Quite extensive experiments have been made with various types of proprietary Bordeaux mixtures, giving special attention both to the effects of variations in their copper content and to their physical properties.

An investigation of some of the newer types of dusting mixtures now appearing on the market as substitutes for liquid fungicides has been conducted in several localities to determine their efficacy against various fungous diseases and their effect on foliage of plants and fruit trees. Special studies of the dry lime-sulphur products as compared with the liquid form are now under way to determine their relative fungicidal values.

The recent developments in the use of dust insecticides for the control of sucking insects have led to a great increase in the number of such preparations on the market. These insecticides are being carefully tested by the entomologists of the board, and special studies are being made to determine facts necessary for the proper interpretation of claims made in labels by manufacturers in reference to nicotine dusts for the control of sucking insects.

The work with calcium arsenate has been continued and special attention has been given to the effect of this material, used alone or with the standard fungicides, on the foliage of apple trees, shade trees, and the ornamental plants.

The dry substitutes for liquid lime-sulphur have been carefully tested as to insecticidal value, in several different parts of the country and under widely varying conditions, and this work is rapidly nearing completion.

The tests with proprietary preparations recommended for the control of chicken mites and the experiments with miscellaneous materials against these mites have been completed, and these data are now being assembled for publication.

Special studies of naphthalene and pyrethrum have been made and a large series of tests carried on to determine the effects on aphids of various percentages of these materials.

In addition to experimental work, considerable useful information has been obtained by visiting orchards and truck patches and observing the results on trees and crops which have been sprayed by growers with proprietary insecticides and fungicides. The value of the insecticide act to the fruit growers was well illustrated in the case of two preparations recommended for use against insects and plant diseases and which were widely advertised and sold during the past year. Both of these preparations were very badly adulterated and misbranded. In one case scientists of the board visited, within a day's drive of Washington, D. C., orchards in which damages estimated at not less than $5,000 had resulted from the use of the material exactly as directed on the label. In the same territory the second article had caused the death of over 400 young apple trees. In neither case did the preparations control the insects and diseases against which they were recommended. Prompt action was taken by the board against these preparations and they are now being sold under labels which conform to the provisions of the insecticide act.

The scientific workers of the Bureau of Animal Industry branch of the board, in cooperation with the Zoological Division of that bureau, have investigated the value of various ingredients frequently found in insecticides recommended for lice. In this connection tests were made with crude mineral oil, kerosene, paraffin, formaldehyde, sabadilla seed, and quassia powder. Efforts to develop a satisfactory treatment for dermodectic mange are in progress and more work is being done experimentally on certain substances in the control and removal of intestinal parasites of domestic animals, with the view of enabling the board to intelligently classify as inert or active various ingredients which enter into the composition of preparations used in the treatment of the conditions mentioned.

# REPORT OF THE FEDERAL HORTICULTURAL BOARD.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FEDERAL HORTICULTURAL BOARD,
*Washington, D. C., October 1, 1922.*

SIR: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ended June 30, 1922.

Respectfully,

C. L. MARLATT,
*Chairman of Board.*

HON. HENRY C. WALLACE,
*Secretary of Agriculture.*

## FIELD COVERED.

The Federal plant quarantine act has for its object the prevention of entry into the United States of new and important insects or plant diseases injurious to agriculture, horticulture, and forestry, and the prevention of spread in the United States of any such pests which may have gained more or less limited foothold. In connection with the latter, the board is charged, either directly or in cooperation with the bureaus concerned, with the control and, if practicable, the eradication of such pests. To give such protection now involves the administration and enforcement of some 22 foreign and 15 domestic quarantines.

A brief record of the more important of the activities of the board is given in this report, including statistics of the importation of such controlled products as cotton, potatoes, fruits, nursery stock, etc. The detailed record of the work of the board, in relation to its various quarantine and other special subjects, is given permanent record in the Service and Regulatory Announcements published from time to time during the year.

## CONTROL OF IMPORTANT NEW PLANT PESTS.

The Department of Agriculture is now attempting to prevent the spread and in some instances to eradicate a number of important introduced pests which still have a rather limited foothold. These include, among insect pests, the pink bollworm of cotton, the European corn borer, the gipsy and brown-tail moths, the Japanese beetle, and a number of minor enemies. Among plant diseases, similar control is being attempted in the case of the potato wart, white-pine blister rust, citrus canker, and certain diseases of small grains. The progress made in this work will be briefly summarized

## THE PINK BOLLWORM.

### PRESENT STATUS.

The work of eradicating the pink bollworm is in better status now than ever before, both from the standpoint of substantial reduction as to the infested areas and of suitable legislation and efficient cooperation on the part of the States and planters concerned.

As a result of interstate cotton conferences held in Washington and in Texas in 1921, fairly adequate State legislation has been obtained and good cooperation is being had with the States in this effort at eradication.

The real danger will come just at this period when the insect seems to be practically eliminated, and planters and others may come to the false conclusion that it is not necessary to continue the work and cost. The inspection and field work is more necessary and should be prosecuted with more intensity at this stage than at any other if ultimate success is to be gained.

Incidentally it may be said that this effort at eradication has resulted in the protection at a comparatively trivial cost of the cotton crop not only of the three States concerned but probably of the entire South, and, whatever the outcome of the effort, has been tremendously worth while from this standpoint alone.

As to Louisiana, no infestations by the pink bollworm were found in any of the old areas or elsewhere in the State in 1921, nor has there been any reappearance in that State determined so far this year (October 1, 1922). Louisiana may, therefore, be looked upon as possibly free from the pest.

In Texas, as to the older infestations in the eastern part of the State, but a single infested boll containing a single larva of the pink bollworm was found in the large Trinity Bay district in 1921. There has been no return of the pest in the Hearne district since the original clean-up in 1917, and this area may now be released as absolutely free from the pest. In the western areas of infestation in the Pecos Valley and in the Rio Grande Valley near El Paso, noncotton zones have never been established, and the pink bollworm reappeared very scatteringly in 1921, as was to have been expected. As long as the outcome in eastern Texas was uncertain, neither the planters nor the State authorities have been willing in these western areas to abandon the growth of cotton in an effort to completely eradicate the pest, but if it can be held to these western areas, which are separated by wide and uncultivated and fairly desert tracts from eastern cotton cultivation, they will present very little greater risk than occurs from the pink bollworm in Mexico.

The situation in New Mexico in the Rio Grande Valley and in the upper Pecos Valley is similar to that in western Texas.

The only new outbreaks by the pink bollworm during 1921 were two very incipient infestations in Ellis and Grayson Counties, in northern Texas, originating from shipments of seed from Carlsbad, N. Mex., made prior to the determination by the department of infestation at the latter point. These new outbreaks were immediately and vigorously taken hold of by the State and Federal authorities and thoroughly cleaned up and noncotton and surrounding regulated zones established for 1922. No infestation of the crop of 1922 near these points has so far developed. They present a situation no more serious than was Hearne in 1917, from which district the pink bollworm was completely eradicated with one year's clean-up.

Up to October 1, 1922, the only recurrences of the pink bollworm which have been determined have been in three fields on the Rio Grande in the Great Bend district. Necessarily in this area, with the possibilities of reinfestation from Mexico, the pink bollworm may be expected to occur in greater or less numbers any year. Fortunately, this area is a very unimportant cotton district and is isolated from other cotton regions.

### SCOUTING WORK.

As a basis for the knowledge of the present status of this pest, very intensive inspection has been carried out during the present season in the States of Louisiana, New Mexico, Oklahoma, and Texas, involving a total of nearly 2,000 workdays. This inspection will continue throughout this year, and it is probable that additional points of infestation may be later determined.

The success or failure of the entire extermination project depends on the thoroughness and efficiency of such scouting and inspection work. In addition to the States listed which are directly concerned this scouting has been extended to 12 other important cotton States, following up records of possibly infested material, and this work has been so thoroughly done that there is every reason to believe that the pink bollworm has not reached any of these States and that its known limits within the United States have been fairly accurately determined. An additional feature of this work is the scouting along the Mexican border in Mexico as a basis for border quarantine control.

### CLEAN-UP WORK OF 1921.

In connection with the infestations found during the year 1921, clean-up operations were carried out as in former years. With respect to the new infestations in northern Texas, 802 acres were cleaned in Ellis County and 721 acres in Grayson County. In addition to the work done in northern Texas, the fields in practically the entire Trinity Bay area were cleaned. On account of the very rainy season the acreage in this district had been greatly reduced. The areas cleaned comprise 2,736 acres. The greater availability of labor in 1921 enabled the department to conduct this work very much cheaper or at almost half the cost of similar work in previous years under war conditions. In 1921 all the work in the Trinity Bay area was done by contract with farmers, whereas in previous years it had been necessary in many cases to obtain labor in the city and transport it and maintain it in the field. The total expenditure for clean-up work in 1921 was $20,115.78 and involved altogether 4,259 acres, or a cost of approximately $4.50 per acre.

### FEDERAL PARTICIPATION IN COMPENSATION OF FARMERS.

The provision for participation with the States in compensation of farmers in noncotton zones given in the act of Congress approved August 9, 1921, has led to the disbursement to the State of Louisiana the sum of $41,971.64 and to the State of Texas $610 as to the crop of 1921. The smaller sum for Texas is due to the fact that that State had already settled most of the claims of its farmers prior to the passage of the joint resolution of Congress. This participation by the Federal Government has been of tremendous service in stimulating cooperation on the part of both States and planters.

### PROGRESS IN DISINFECTION OF COTTON SEED.

In Egypt one of the current methods of reducing the numbers of pink bollworms is to heat the seed in the process of ginning. It was found in preliminary experiments conducted in this country that the problem was quite different here on account of the insulation due to lint adhering to the seed, which is practically absent in the case of Egyptian seed. Experiments have been undertaken in Texas and Mexico in cooperation with the Texas Experiment Station and Department of Agriculture to determine the temperature to which seed could be heated without reducing its vitality, and suitable apparatus has been devised for such treatment. As a result of this work it has been determined that heating the seed to a temperature of 145° F. would destroy all infestation but would not lower the vitality of the seed. Such disinfection is now required under Texas law in all districts regulated on account of the pink bollworm, and disinfecting machines have been provided in practically all gins in such districts. The crop of 1922 is being handled through these machines, which are interposed between the seed house and the gins, so that the disinfecting becomes an automatic part of the process of ginning.

### RESEARCH WORK IN MEXICO.

The scientific and research phases of the subject have been conducted as hitherto in the Laguna district, Mexico, and very important information has there been obtained relative to the habits and control of the pest. This work is being conducted on a very small appropriation ($5,000), but it is very desirable to considerably extend this work, and a fund of $10,000 is requested for the year 1924. One important and very practical phase of this work is the determination that the pink bollworm can not as a rule survive in moist soil, and therefore the clean-up operations practiced by this department in Texas and other States—i. e., the destruction of all standing and scattered cotton and bolls—have undoubtedly had much of their success from the fact that any remaining larvæ and bolls have been those buried in moist soil. It has been shown that with infested bolls so buried from 95 to 99 per cent of the larvæ perish.

### INVESTIGATIONS OF THE PINK BOLLWORM IN THE WEST INDIES.

The determination of the occurrence of the pink bollworm in the island of St. Croix, one of the Virgin Islands belonging to the United States, and also in the islands of St. Kitts and Montserrat in the West Indies, made it desirable, in view of the close commercial relations, interisland and with the United States, to have accurate information as to the extent of the foothold of this pest throughout the West Indies. For this purpose August Busck, entomological assistant of the board, spent several months in this investigation, which included the British and Dutch Guianas, Trinidad, and the islands northward, including the Virgin Islands, and also Porto Rico, Santo Domingo, and Cuba.

The pink bollworm was determined as occurring from Montserrat north and west, including the British and Virgin Islands, and in Porto Rico and Santo Domingo. No infestation was found south of Montserrat. The fairly brief survey of Cuba did not result in the detection of this pest in that island. It was hoped that the pink bollworm would prove to be limited to a few of the smaller islands and that it would be practicable to recommend efforts at extermination—efforts, in fact, which the insular authorities, British and American, either had already undertaken or were willing to undertake. The determination, however, of the wide infestation of this pest in Porto Rico and of its having obtained a foothold in Santo Domingo, together with the cultural and vegetative conditions of these two larger islands and the abundance of wild cotton growing on them, made it, in the judgment of the experts of the department, inadvisable to recommend a general campaign of eradication. It was realized that unless it was possible to eradicate the pest from these larger islands it would be very difficult, if not impossible, to prevent repeated reinfestation of the smaller islands. Control in the smaller islands becomes, therefore, a local matter to be administered, if this is possible at a reasonable cost, by the islands concerned. These conclusions were the outcome of a general conference held on the subject by the board in Washington December 20, 1921.

The infestation in the West Indies apparently came from an importation of Egyptian cotton seed in 1911–12 into the island of St. Croix, then under Danish control, by the director of the island experiment station and the later distribution from this point of planting seed to other islands.

The existing quarantines on account of the pink bollworm now protect the United States from movement of cotton, cotton seed, etc., from the West Indies, including the American islands.

### MEXICAN BORDER CONTROL.

The border control to prevent entry of the pink bollworm from Mexico is a continuing work. In connection with it the enforcement of various fruit and grain quarantines against Mexico is taken care of by the department's inspectors. During the fiscal year ended June 30, 1922, 35,747 freight cars were inspected in Mexican border towns for cotton seed, and of this number, 31,579 were fumigated immediately upon arrival in the American port of entry. At Del Rio, Tex., where there are at present no railroad connections, 31,861 vehicles of various descriptions were examined, 69 of which were fumigated on account of the presence of cotton seed at the time of inspection. Fumigation fees amounting to $126,350.50 were collected and turned into the Treasury.

The amount of car fumigation and other work involved increased very greatly during the last fiscal year, due to the improved conditions in Mexico and the corresponding increase in freight and other traffic between Mexico and the United States. As a result it became necessary to call upon Congress for a supplemental appropriation, and $50,000 was so appropriated in connection with the urgent deficiency act approved March 20, 1922. As noted, the moneys so expended very largely are returned to the Treasury of the United States from the charges made for such car and other fumigation—charges based on the cost of chemicals and labor involved.

The inspection at the footbridges, in cooperation with the customs officials located at Brownsville, Laredo, Eagle Pass, and El Paso, Tex., as well as the boundary line at Nogales, Ariz., has been continued for the purpose of preventing the entry of cotton and cotton seed, as well as other plant products covered by quarantine. A total of 55,511 pieces of contraband material was intercepted as follows: Avocados, 13,422;[1] corn, 4,971; cotton, 1,797; grapefruit, 519; guavas, 2,842; limes, 2,106; mangoes, 1,550; oranges, 8,073; peaches, 8,037; plants, 5,601; plums, 882; potatoes, 951; sapotes, 142; sugar cane, 3,967; sweet potatoes, 651.

## THE CORN BORER.

The administration of the corn-borer appropriation has been assigned to the Bureau of Entomology but in cooperation with this board as to quarantine features. There has been no new outbreak of the corn borer this year; in other words, this pest is still limited, so far as is known, substantially to the areas determined last year, these representing for the most part areas of original infestation from Europe in 1909 and 1910, namely, the New England area, the eastern and western New York areas, and the Ontario area, from which latter it has apparently spread, as determined last year, to the southern and western shores of Lake Erie. There has been during the year a local but limited natural spread of the insect in the case of each of these areas.

It would appear from this record that the quarantine and control measures safeguarding the movement of products from the known infested area have prevented wide jumps of the insect. The funds available for this work, however, have been entirely inadequate for general surveys of other States or areas and no positive claim is made that the department now has information as to the existing distribution of this pest in the United States.

It is very important that the corn-borer work should be continued. There is no question at all as to the importance of this pest of corn. It is a new pest and will be an additional burden on this crop. During the present year it has maintained itself about in the same status as previously in the known areas of infestation, there being certainly no increase of damage in the western areas of invasion in New York, Pennsylvania, Ohio, and Michigan, and, in point of fact, in these areas no material commercial damage has ever resulted. The extensive damage which the insect frequently occasions in the New England area seems to be explainable by the fact that the insect is there double-brooded and that the cultural and crop conditions are peculiarly favorable to its multiplication. The Canadian authorities report that the damage in Ontario this year is very much less than in either of the two previous years (1920 and 1921). This is supposed to be due to better cultural conditions and also to the late planting of corn.

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[1] To permit the local consumption of the avocado fruit at ports on the border of Mexico, the board has authorized the entry of such fruit when stoned or seeded. The avocado weevils which the avocado quarantine is intended to exclude infest the seed and the removal of the seed practically eliminates any danger

The menace of this pest to the main corn areas of the country is still to be determined. It may prove to be a very serious pest when it reaches the great Corn Belt and particularly when it gets into the more southern regions of corn culture. It can certainly always have a very serious phase in connection with table corn for immediate consumption or for canning, and in exceptional seasons with flint and possibly other corn, unless efficient control by natural enemies or other means develops.

There is every reason to continue and adequately support the quarantine work to prevent spread. The effort this year to divide the cost of this work between the States concerned and the Federal Government has been only partially successful. Fair support and cooperation has been obtained from certain States, and very inadequate from others. It becomes, therefore, a question to be seriously considered whether in a menace of this kind which affects the whole country protection should be jeopardized by conditioning the work on State support. In a State where the insect has never done any real damage, it is difficult to arouse interest and get prompt action, and the same is apt to be true in a State where the insect has already pretty well established itself and the benefit of the control is largely in the interest of other States. The neglect or failure of any State may negative both the efforts of other States and the Federal Government. The situation is analogous to the situation in Texas 30 years ago when the boll weevil first appeared, when it was neither possible to arouse the State legislature nor the farmers to take protective action, which at that time would have been a fairly easy and simple proceeding.

### THE JAPANESE BEETLE.

The Japanese beetle quarantine fund is also being administered by the Bureau of Entomology, the board cooperating in quarantine features. It seems desirable here to emphasize the belief of the board that this pest is one of the most dangerous insect introductions made in many years, and threatens large future losses, particularly to fruit and forage crops; to the latter as a grub infesting the soil. This beetle seems to be still limited to the original area of infestation except for the natural spread of some 5 miles a year. In the center of this area, where the insect has become most abundant, the damage to foliage and fruit is very alarming. The ease with which the insect may be carried with produce is also a very disquieting feature; for example, during 1921, out of some 200,000 baskets of sweet corn moving out of the district and subject to inspection, upward of 5,000 beetles were removed. The insect may be carried by almost any of the farm, garden, florist, or nursery products moving out of the district, and in addition is a strong flier.

The quarantine and control work against a pest of this kind can be justified only by the repression of spread and lessening of damage secured. There is no question at all but that this pest will in time spread throughout the United States. The prevention of spread is of immediate value and gives a period during which the insect can be studied and its means of control more fully determined, and more particularly affords opportunity for the introduction from its original home of natural enemies. From this point of view the department would seem fully justified in maintaining for the present the quarantine and other control of this pest which is now in operation.

### THE GIPSY AND BROWN-TAIL MOTHS.

The quarantine control of the gipsy and brown-tail moths is in cooperation with the Bureau of Entomology. The quarantine on account of these two pests has been twice slightly modified during the year. The quarantined area has been extended with respect to the gipsy moth, but with respect to the brown-tail moth it has been possible to reduce very materially the area quarantined on account of this insect.

The new areas determined as infested in New Jersey, New York, and Pennsylvania in 1920–21 remain as formerly under the control of State quarantines, no Federal action having been taken, inasmuch as these State quarantines are being administered in active cooperation with the officers of the Bureau of Entomology of this department. The scattered points of invasion in Pennsylvania, New York, and New Jersey, which resulted from the big central colony at Somerville, N. J., have been apparently eradicated. The Somerville colony has been subjected to thorough clean-up and control work now for two seasons, and the outlook is good for the eradication of this pest in New Jersey.

Two new points of infestation were determined during the year on Long Island, and the clean-up of these areas is actively under way in cooperation with the State officials.

Inspection of products likely to disseminate the gipsy moth has been continued in New England and in New Jersey in cooperation with the State authorities, and shipments have been safeguarded by careful examination.

### DATE SCALE ERADICATION.

There are approximately 20,000 imported date palms now planted in orchards in California, Arizona, and Texas. These special date districts include Coachella and Imperial Valleys in California, Yuma and Salt River Valleys in Arizona, and a small garden at Laredo, Tex. In addition to these planted orchards there are some 12,000 offshoots, recently imported from Algeria and Egypt, now being grown in 4 quarantine nurseries—2 in Indio, Calif., 1 in Yuma, Ariz., and 1 in Phoenix, Ariz. Altogether there are approximately 200 date plantations in the United States, of which 14 are still infested with the Parlatoria date scale. Several of these infested orchards have been almost completely cleaned up during the year, but others are still seriously infested, and among them are half a dozen orchards which contain large-sized palms which require repeated treatments over a considerable period to thoroughly eradicate the scale.

The 12,000 recently imported offshoots are all under close observation, and many of them are likely to develop scale infestation later on, even if they are now apparently clean, and these plantings must therefore be kept under observation for a considerable period of years before the plants can be taken out of quarantine and distributed.

More than 100 of the date plantations in the United States have been completely cleaned up within the past eight years by the methods now being followed, and it is believed that the remaining infested groves can be similarly cleaned up within the next few years.

The Parlatoria scale is so destructive to the date palm that the experts of the Bureau of Plant Industry and all others who have studied the matter agree that dates can not be grown in this country profitably unless the Parlatoria scale is completely eradicated. The whole future of this promising industry, which is so admirably adapted to the irrigated valleys of the Southwest, is therefore tied up with the success of the Parlatoria eradication work. Several million dollars have already been invested in date culture and the industry is a rapidly growing one.

During the past year a very efficient corps of date-scale inspectors has been trained, and rapid progress is being made in the work of eradication of the scale. The State and county officers of California and Arizona have given most thoroughgoing cooperation in this campaign of eradication.

### THE PINE BLISTER RUST.

The Federal quarantines on account of this disease are being administered in cooperation with the Bureau of Plant Industry. The important development in the white pine blister rust situation was the discovery in the fall of 1921 of the establishment of this disease in southwestern British Columbia and in the Puget Sound region of Washington. The department, in cooperation with State and Canadian authorities, took prompt action to determine the extent of the infected area and to control or eradicate this new outbreak. The condition of the infected pines indicates that the disease must have been present in British Columbia as early as 1911. The infection is widely distributed on native western white pine and cultivated black currants in British Columbia, the most important location being at Revelstone, about 120 miles north of Idaho. This year cultivated black currants infected with the rust have been found in Washington in the counties of Whatcom, San Juan, Skagit, Island, Clallam, Pacific, and a single infected planted pine (*Pinus monticola*) was found at Blaine, Wash. In 1921 two small pines infected with blister rust were found in a nursery at Mount Vernon, Wash.

A Federal quarantine was established, coinciding with the Washington State quarantine and including the known infected area, to prevent the movement of five-leafed pines, currant and gooseberry plants out of that portion of Washington lying west of the summit of the Cascade Mountains.[1]

As to the eastern areas of blister rust invasion, Federal Quarantine No. 26, which prohibits the movement of blister rust host plants from States east of and including Minnesota, Iowa, Missouri, Arkansas, and Louisiana interstate to points west of the quarantine line, has been continued to prevent the introduction and spread of the disease into uninfected regions. In the enforcement of this quarantine 70,180 shipments of nursery stock were examined for blister rust host plants during the past year. There were intercepted 135 shipments in violation of the quarantine, 93 per cent of which were returned to the consignor and the remainder disposed of by consignee or State officials. The number of violations by nurserymen was reduced from 81 per cent in the spring of 1921 to 50 per cent in the spring of 1922. The increasing effectiveness of the quarantine is shown by this marked reduction in the number of violations by nurserymen. Practically all violations by nurserymen are found to result from neglect or carelessness on the part of nursery employees. This condition has been corrected through improved methods when brought to the attention of nurserymen. Violations by individuals not in the nursery business are invariably committed through lack of knowledge of quarantine regulations. In conducting quarantine inspection work the department has received excellent cooperation from the Post Office Department, common carriers, nurserymen, and State officials.

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[1] Owing to a recent change in the Washington State blister rust quarantine, it has become necessary to extend the Federal quarantine to the entire State of Washington, instead of only that portion of the State west of the summit of the Cascades.

### THE POTATO WART.

The European potato wart is still restricted in the United States to about 800 gardens situated entirely in mining villages in Pennsylvania, West Virginia, and Maryland. Nearly all standard American potato varieties have been tested for reaction to wart and many immune varieties have been determined, so that this disease does not now have the menace to this country which it originally had. In the invaded districts these immune varieties are now for the most part being grown under regulations enforced by the States concerned and the danger from these districts is thus being very greatly minimized.

A large volume of work has been accomplished in a study of this disease both from the technical standpoint of the disease itself and its control and also the determination of the reaction of varieties of potatoes to it as to immunity. It is proposed, after this year, to discontinue much of the research work which has hitherto been carried out by the board in cooperation with the Bureau of Plant Industry. An appropriation for the board for the next fiscal year has been asked for of only $5,000 for cooperation in quarantine work and for some essential survey work. It is understood that the Bureau of Plant Industry will continue such technical research work in connection with the disease as may be necessary.

The board does not feel, however, that the time has come when it is either necessary or desirable to open the ports of the United States to the importation of foreign potatoes from countries known to be invaded by this disease. Such action would probably result in the extension of this disease to practically all the potato regions in the United States, and might very shortly involve a very serious consequence where the nonimmune rural-group varieties are the main dependence.

### MISCELLANEOUS QUARANTINES.

The citrus canker and various diseases of small grains are subject to foreign quarantines promulgated by the board. The local or domestic control of these diseases is carried out by the Bureau of Plant Industry in cooperation with the board.

## THE NURSERY STOCK, PLANT, AND SEED QUARANTINE.

### CONFERENCE OF MAY 15, 1922.

Quarantine No. 37, regulating and conditioning the entry of foreign plants and seeds for propagation, has been in force for over three years, and while in its main features it has been recognized and accepted as necessary for the protection of the country from the entry of new pests, there have been objections to certain phases of the quarantine from time to time on the part of certain interests and individuals. To give opportunity for a full and free discussion of the whole subject of quarantine No. 37 a conference was called at Washington for May 15. This conference was largely attended, both by representatives of the various trade associations, the important horticultural and agricultural societies and associations, national and regional, and State horticultural, agricultural, and quarantine officials. There were also in attendance numerous individuals interested in the horticultural trades involved; also foreign delegates representing England, Holland, Belgium, and France.

It is believed that a better understanding of the need of safeguarding the country against the possible introduction of destructive pests and diseases has resulted from this conference, and also that it has cleared up a good many of the prejudices and mistaken ideas that existed concerning quarantine No. 37 and its operation.

At the conclusion of the conference provision was made by the department to take up certain special subjects which needed more intimate discussion at some time convenient to the department and the interests involved. Among the subjects to be thus considered are the questions of bulb importations and possibly orchids and certain classes of florist and nursery stock.

No plants or classes of plants are specifically excluded by quarantine No. 37. On the other hand, the quarantine makes provision for the entry of any plants for which a real horticultural or experimental need can be shown, and under it very large importations of what are often styled "prohibited plants" are being constantly made. (See records of importations of nursery stock plants and seeds, p. 17).

The records in the possession of the department fully demonstrate that any importation of any class of plants is attended with greater or less risk of bringing in new enemies in spite of all safeguards of inspection and disinfection. The protection which the country needs and demands therefore involves the exclusion of all stock not absolutely essential to the horticultural, floricultural, and forestry needs of the United States, and that is just what quarantine No. 37 attempts to do and must do if it is to be of any real service in excluding plant pests.

In this connection it is perhaps proper to point out that in connection with the importations which were permitted during the fiscal year 1922 there were intercepted upward of 500 different species of insect pests and also a considerable number of plant diseases. As a single example, in connection with importations in 1921 of fruit and rose seedlings from France, no less than 182 brown-tail moth nests were intercepted, distributed among some 41 different shipments. That this represents a growing carelessness on the part of the French exporter is indicated by the fact that in the nine preceding years only 63 such nests were found altogether. This alarming state of affairs led to emphatic warnings being given to the French exporters and inspection authorities, with the result that so far this year there has been a very marked improvement, only two such nests having so far been taken. There was, however, a decided increase in pests of other kinds and many of them important pests new to this country.

### CERTAIN MAIL ENTRY OF PLANTS NOW PERMITTED.

The importation by mail has hitherto been prohibited of plants and seeds for propagation, except field, vegetable, and flower seeds and importations made by or for the Department of Agriculture. Inasmuch as importations made by special permit under regulation 14, quarantine No. 37, are required to be addressed to the Federal Horticultural Board, United States Department of Agriculture, and are under complete control of the department until they are passed and distributed to ultimate destination, they can properly be considered as complying with the post-office order limiting mail importations of plants other than as indicated to those addressed to and intended for this department. By arrangement with the customs service and the Post Office Department, importation through the mails of special permit material is authorized when warranted by the nature and amount of the proposed shipment.

### HORTICULTURIST ADDED TO BOARD'S STAFF.

In connection with all requests for special permits under regulation 14 for the importation of new varieties of plants and necessary propagating stock, the board has adopted the policy from the beginning of issuing such permits only on the recommendation and advice of the experts of the Bureau of Plant Industry as approved by the chief of that bureau. The burden of this work has been rather heavy, and as a means of facilitating the examinations and lessening the bureau's work, the board had added to its staff Prof. David Lumsden, a horticulturist of wide professional and practical experience.

There have been issued during the year a number of circulars giving explanation of the provisions for plant entry under quarantine No. 37. These have been distributed to all parties in interest.

## RECORD OF ENTRY OF RESTRICTED PLANTS AND PLANT PRODUCTS.

Under various foreign quarantines the entry of certain plants and plant products is restricted and made subject to inspection, and, if necessary, disinfection as a condition of entry. These include cotton, cotton waste, cotton wrappings, and cottonseed products for the purpose of excluding the pink bollworm and other dangerous cotton pests; nursery stock, plants, and seeds for propagation for the purpose of excluding miscellaneous foreign pests—insect and disease; also potatoes from various foreign countries for the purpose of excluding potato diseases and insect pests; and various fruits and grains. The records of the importations of the more important of these subjects are indicated in the following discussion and tables:

### COTTON, COTTON WASTE, COTTON BAGGING, AND COTTONSEED PRODUCTS IMPORTATIONS.

Except as noted below, disinfection is a condition of entry of all cotton, and entry is restricted to Boston, New York, San Francisco, and Seattle. Disinfection plants under private ownership and management, but under the supervision of Federal inspectors, are located at those ports.

Returned American cotton in original containers originating outside of the areas in New Mexico, Texas, and Louisiana quarantined on account of the pink bollworm, and cotton grown in the Imperial Valley, Lower California, Mexico, may enter without disinfection. The entry of unrestricted American cotton is permitted at all ports where the board maintains inspection service. Entry of cotton from the Imperial Valley is restricted to Calexico.

Cotton waste is classified as restricted and unrestricted. The former is waste which has not been manufactured or processed so as to have eliminated all seed. Disinfection of such waste is therefore a condition of entry, and entry is permitted at the ports of Boston, New York, San Francisco, and Seattle only. Unrestricted waste contains no seed and its entry is permitted at all ports where the board has inspectors, viz, at Philadelphia, Baltimore, New Orleans, and Portland, Oreg., in addition to the ports mentioned.

Bagging or other fabrics of the kinds ordinarily employed in wrapping cotton is also classified as restricted and unrestricted. Unrestricted bagging is (1) bagging which has not been previously used as cotton wrappers or containers and (2) American cotton bagging commonly known as coarse gunny which has been used to cover only cotton grown in the United States. Such material may enter at the following ports: Boston, New York, Philadelphia, Baltimore, Norfolk, Charleston, New Orleans, Portland, San Francisco, and Seattle. Under special arrangements with the collectors of customs at Detroit and Port Huron entry of unrestricted bagging not previously used as cotton wrappers is permitted at those ports. Material not falling under the classes enumerated is referred to as restricted. Permits for the entry of restricted bagging are issued for the ports of Boston, New York, Philadelphia, Baltimore, Portland, San Francisco, and Seattle. Disinfection is a condition of entry of restricted bagging. Disinfection may be accomplished at the disinfection plants above referred to or in process of manufacture approved by the board.

Cotton has been under restriction since 1915—seven years. The importations of cotton for this year (1921–22), 386,303 bales, exceed last year's imports by 165,000 bales and are the second largest made in any fiscal year since that date. They are exceeded by those made in 1919–20 only. (See tables below.) The totals of the importations during the last seven years are as follows:

| Year. | Bales. | Year. | Bales. |
|---|---|---|---|
| 1915–16... | 316,260 | 1919–20..... | 595,765 |
| 1916–17... | 216,337 | 1920–21..... | 221,303 |
| 1917–18..., | 195,723 | 1921–22..... | 386,303 |
| 1918–19... | 179,537 | | |

It is interesting to note that the importations of Brazilian cotton in 1921–22 are more than double the largest previous imports from Brazil. The imports of Egyptian cotton are the third largest since the cotton records have been kept. The same is true of Haitian cotton, while imports from India for the past year show the second largest importations from that country. Peru has entered 101,132 bales, the largest number recorded from Peru. The importations of returned American cotton exceed last year by approximately 8,000 bales, 16,405 bales having been entered. The majority of the returned American cotton has come from Germany.

The importations of waste show a decrease of about 14,000 bales in last year's importations. However, they fall short of the largest annual importation by about 19,000 bales only.

The importations of bagging, totaling 65,714 bales, bring this year's bagging imports to third place in size of annual importations of that commodity. They show a decrease from last year's importations of about 8,000. The largest importations of bagging were made in 1919-20, when 163,383 bales were entered. Such bagging was, however, an accumulation of that material gathered during the period of the war.

Cottonseed products, including cottonseed oil, are prohibited from Mexico except when they originate in mills in the Laguna district. Cottonseed products, except oil, from all foreign countries are under restriction. Cottonseed products entered during this year show a decrease from the importations of last year. The decrease is particularly noticeable in importations through the port of San Francisco and Eagle Pass.

During the year, 1,309 permits to import cotton, etc., were issued and 184 mills were licensed to use such cotton.

The accompanying tables indicate, respectively, the importations of cotton, cotton waste, bagging, cotton seed, seed cotton, and cottonseed products during the fiscal year.

*Imports of ginned cotton, by country of origin and port of entry, 1921–22 (bales).*

| Country of origin. | Boston. | Calexico. | New Orleans. | New York. | Norfolk. | Philadelphia. | Port Huron. | Richford. | St. Albans. | San Francisco. | Savannah. | Seattle. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brazil |  |  |  | 11,366 |  |  |  |  |  |  |  |  | 11,366 |
| British West Indies |  |  |  | 1,335 |  |  |  |  |  |  |  |  | 1,335 |
| China | 3,300 |  |  | 11,321 |  |  |  |  |  | 500 |  | 541 | 15,662 |
| Colombia |  |  |  | 67 |  |  |  |  |  |  |  |  | 67 |
| Dutch East Indies |  |  |  | 930 |  |  |  |  |  |  |  |  | 930 |
| Ecuador |  |  |  |  |  |  |  |  |  | 1 |  |  | 1 |
| Egypt | 140,416 |  |  | 22,044 |  |  |  |  |  |  |  |  | 162,460 |
| Haiti |  |  |  | 8,872 |  |  |  |  |  |  |  |  | 8,872 |
| India | 5,806 |  |  | 7,216 |  |  |  |  |  |  |  |  | 13,022 |
| Mexico |  | 54,146 |  |  |  |  |  |  |  |  |  |  | 54,146 |
| Peru | 3,300 |  |  | 97,832 |  |  |  |  |  |  |  |  | 101,132 |
| Porto Rico |  |  |  | 764 |  |  |  |  |  |  |  |  | 764 |
| Santo Domingo |  |  |  | 134 |  |  |  |  |  |  |  |  | 134 |
| Union of South Africa |  |  |  | 7 |  |  |  |  |  |  |  |  | 7 |
| United States | 13,195 |  | 1,339 | 1,055 | 200 | 194 | 1 | 62 | 100 | 2 | 257 |  | 16,405 |
| Total | 166,017 | [1] 54,146 | 1,339 | 162,943 | 200 | 194 | 1 | 62 | 100 | 503 | 257 | 541 | 386,303 |

Includes 9,731 bales unginned cotton from Imperial Valley, Lower California, Mexico.

*Imports of cotton waste, by country of origin and port of entry, 1921–22 (bales).*

| Country of origin. | Boston. | Detroit. | New York. | Philadelphia. | Portland. | San Francisco. | Seattle. | Total. |
|---|---|---|---|---|---|---|---|---|
| Canada | 3,125 | 25 | 81 | 61 | | | | 3,292 |
| China | | | 3,606 | | 202 | 105 | | 3,913 |
| England | 303 | | 1,041 | 1,242 | | | 5 | 2,591 |
| France | | | 301 | 87 | | | | 388 |
| Germany | 92 | | 1,873 | 97 | | | | 2,062 |
| Holland | 9 | | 179 | | | | | 188 |
| India | | | 3,003 | | | | | 3,003 |
| Italy | | | 2,614 | 87 | | | | 2,701 |
| Japan | 200 | | 2,461 | | 65 | | 1,240 | 3,966 |
| Scotland | | | 61 | | | | | 61 |
| Spain | 2 | | | | | | | 2 |
| United States | | | | | | | 251 | 251 |
| Total | 3,731 | 25 | 15,220 | 1,574 | 267 | 105 | 1,496 | 22,418 |

*Imports of cotton bagging, by country of origin and port of entry, 1921–22 (bales).*

| Country of origin. | Baltimore. | Boston. | Charleston. | New Orleans. | New York. | Norfolk. | Philadelphia. | Port Huron. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Algeria | | | | | 53 | | | | 53 |
| Belgium | 3,896 | 1,090 | 1,488 | 2,753 | 2,887 | 338 | 773 | | 13,225 |
| Canada | | 515 | | 3,087 | | | | 873 | 4,475 |
| Denmark | | | | | 605 | | | | 605 |
| England | 1,816 | 1,618 | | 3,069 | 6,363 | 11,008 | | | 23,874 |
| France | 135 | | 1,262 | 3,774 | 3,684 | | | | 8,855 |
| Germany | | 71 | 1,505 | 2,729 | 2,706 | 1,387 | 855 | | 9,253 |
| Holland | 270 | 68 | 1,653 | | 2,603 | 90 | 403 | | 5,087 |
| Scotland | | | | | 287 | | | | 287 |
| Total | 6,117 | 3,362 | 5,908 | 15,412 | 19,188 | 12,823 | 2,031 | 873 | 65,714 |

*Imports of cotton seed, seed cotton, and cottonseed products, 1921–22 (tons).*

| Port of entry. | Seed cotton. | Cotton seed. | Cottonseed cake. | Cottonseed meal. |
|---|---|---|---|---|
| Boston | | | 985 | 6 |
| Calexico | 7,299 | 25,351 | | |
| Eagle Pass | | | 1,320 | |
| Laredo | | | 355 | |
| New York | | | | 440 |
| San Francisco | | | 1 | |
| Total | [1] 7,299 | 25,351 | 2,661 | 446 |

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[1] Shown in cotton tables as 9,731 bales of unginned cotton.

## IMPORTATIONS OF NURSERY STOCK, PLANTS, AND SEEDS.

Under regulation 3 of quarantine No. 37, certain important classes of plants are open to unlimited importation under continuing permits, upward of 5,000 of which have already been issued. The three tables following give a record of the importations under this regulation during the fiscal year 1922, representing respectively the importations of fruit, rose, and nut stocks; bulbs and tree seeds. Under regulation 2 of the quarantine, field, vegetable, and flower seeds, as well as all fruits, vegetables, cereals, and other plant products imported for medicinal, food, or manufacturing purposes, are free from all restrictions, even the taking out of a permit, and hence no records of the importations of these classes of seeds and plant products are collected by the board.

*Importation of fruit, rose, and nut stocks (figures indicate number of plants).*

| Kind of stocks. | Country of origin. | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Belgium. | Cuba. | England. | France. | Holland. | Ireland. | Italy. | Luxemburg. | Norway. | Scotland. | |
| Fruit: | | | | | | | | | | | |
| Apple | | | 150 | 3,983,150 | 298,650 | | 290,300 | | | | 4,572,250 |
| Cherry | | | | 8,014,500 | 671,000 | | | | | | 8,685,500 |
| Grape | | | 12 | 65,310 | | | | | | | 65,322 |
| Pear | | | | 2,627,041 | 68,500 | | 117,400 | | | | 2,812,941 |
| Pineapple | | 174,600 | | | | | | | | | 174,600 |
| Plum | | | | 2,460,700 | 81,000 | | 487,500 | | 50 | | 3,029,250 |
| Quince | | | | 921,300 | 30,525 | | 11,150 | | | | 962,975 |
| Not specified | | | | 7,000 | | | | | | | 7,000 |
| Rose | 2,050 | | 1,871,600 | 2,432,040 | 2,325,933 | 100,000 | | 500 | | 40,000 | 6,772,123 |
| Nut: | | | | | | | | | | | |
| Chestnut | | | | 6,000 | | | | | | | 6,000 |
| Walnut | | | | 14,000 | | | | | | | 14,000 |
| Not specified | | | | 12,400 | | | | | | | 12,400 |
| Total number of stocks | 2,050 | 174,600 | 1,871,762 | 20,543,441 | 3,475,608 | 100,000 | 906,350 | 500 | 50 | 40,000 | 27,114,361 |

*Importation of bulbs (figures indicate number of bulbs).*

| Country of origin. | Crocus. | Hyacinth. | Lily. | Lily of the valley. | Narcissus. | Tulip. | Unclassified. | Total. |
|---|---|---|---|---|---|---|---|---|
| Azores | | | 19,000 | | | | | 19,000 |
| Bermuda | | 6 | 179,030 | | 250 | | | 179,286 |
| China | | | 2,520 | | 1,000,515 | | | 1,003,035 |
| England | | 75 | 7,806 | | 325,610 | 5,533 | | 339,024 |
| France | | 1,070,210 | 616,957 | | 40,552,251 | 71,690 | | 42,311,108 |
| Germany | | | | 12,628,700 | | 50 | | 12,628,750 |
| Holland | 6,319,082 | 23,730,195 | 159,678 | 2,322,470 | 35,014,752 | 64,769,667 | 70,750 | 132,386,594 |
| Italy | | 7,750 | 2,524 | | 375,250 | | | 385,524 |
| Japan | | | 7,231,945 | | 1,920 | | | 7,233,865 |
| Total | 6,319,082 | 24,808,236 | 8,219,460 | 14,951,170 | 77,270,518 | 64,846,940 | 70,750 | 196,486,186 |

*Importation of tree seeds (figures indicate number of pounds).*

| Country of origin. | Apple. | Cherry. | Nuts and palm. | Ornamental and tree. | Pear. | Persimmon. | Plum. | Quince. | Rose. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| Australia | | | 57,801 | 124 | | | | | | 57,925 |
| Austria | | 1,550 | | 3,073 | | | 200 | | 100 | 4,923 |
| Brazil | | | 1,276 | | | | | | | 1,276 |
| British Guiana | | | 304 | | | | | | | 304 |
| Canada | | | | 120 | | | | | | 120 |
| Ceylon | | | 75 | | | | | | | 75 |
| Chile | | | 5 | | | | | | | 5 |
| Cuba | | | 105 | | | | | | | 105 |
| China | | | 294 | 278 | 72 | | 100 | | | 744 |
| England | | | 380 | | | | | | | 380 |
| France | 30,252 | 3,337 | 44 | 5,749 | 479 | | 4,569 | 8 | 53 | 44,491 |
| Germany | | 110 | 166 | 2,893 | 5 | | 110 | | | 3,284 |
| Holland | | | | 80 | | | | | | 80 |
| Honduras | | | 150 | | | | | | | 150 |
| Italy | | 100 | | | | | 309 | | | 409 |
| Japan | | 4 | 2,102 | 5,535 | 2,907 | 143 | 308 | | 760 | 11,759 |
| Poland | | | | 983 | | | | | | 983 |
| Siam | | | 375 | | | | | | | 375 |
| Spain | | | | 304 | | | | | | 304 |
| Sweden | | | | 25 | | | | | | 25 |
| West Indies | | | 1,100 | | | | | | | 1,100 |
| Total | 30,252 | 5,101 | 64,177 | 19,164 | 3,463 | 143 | 5,596 | 8 | 913 | 128,817 |

The distribution within the United States of the classes of nursery stock recorded in the above tables is indicated in the following table. This table is interesting and fairly important as indicating the wide distribution of such imported plants and seeds. Under the provisions of the quarantine, the classes of plants and seeds open to unlimited introductions go from port of entry directly to the State and place of destination, and the detailed inspection of these shipments is, under the provisions of the quarantine and of the plant quarantine act, carried out by State authority. The responsibility, therefore, for the ultimate passing of this material and the safeguarding of it from plant enemies rests with the States concerned. Where possible, a mere preliminary inspection is made at the port of entry by department inspectors to determine compliance of the shipment as a whole with the conditions of entry as to kind of stock, certification, freedom from earth, etc. A percentage inspection is, however, made of most bulb importations, more particularly for the reason that State inspectors as a rule are enabled to follow up the distributions of such bulbs to the numerous destination points.

*Distribution, by States, of nursery stock and seeds imported under regular permit (figures indicate number of cases unless otherwise designated).*

| State. | Bulbs. | Fruit stocks. | Rose stocks. | Nut stocks. | Seeds (by pounds). | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Fruit. | Nut and palm. | Ornamental and tree. | Rose. | Total. |
| Alabama | 378 | 33 | 2 | ........ | 23 | 452 | 28 | ...... | 503 |
| Alaska | 4 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Arizona | 17 | ........ | ........ | 1 | ........ | ........ | ........ | ...... | ........ |
| Arkansas | 100 | 7 | 1 | ........ | ........ | ........ | ........ | ...... | ........ |
| California | 3,754 | 28 | ........ | ........ | 337 | 12,801 | 1,154 | 50 | 14,342 |
| Colorado | 826 | ........ | 81 | ........ | ........ | 84 | 13 | 38 | 135 |
| Connecticut | 2,031 | 74 | 8 | ........ | 9 | 1,266 | 51 | ...... | 1,326 |
| Delaware | 288 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| District of Columbia | 518 | ........ | 1 | ........ | 45 | ........ | 38 | ...... | 83 |
| Florida | 70 | 14 | ........ | ........ | ........ | 4,291 | 172 | ...... | 4,463 |
| Georgia | 1,215 | ........ | ........ | ........ | ........ | 210 | 1,600 | ...... | 1,810 |
| Idaho | 28 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Illinois | 28,254 | 16 | 61 | ........ | 100 | 3,964 | 3,430 | ...... | 7.494 |
| Indiana | 1,299 | 31 | 77 | ........ | ........ | 75 | ........ | ...... | 75 |
| Iowa | 1,087 | 122 | 15 | ........ | 10,675 | ........ | 844 | ...... | 11,519 |
| Kansas | 518 | 20 | ........ | ........ | 19,739 | 84 | 76 | ...... | 19,899 |
| Kentucky | 799 | 1 | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Louisiana | 288 | ........ | ........ | ........ | ........ | 188 | ........ | ...... | 188 |
| Maine | 515 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Maryland | 897 | 21 | 3 | ........ | ........ | 300 | ........ | 95 | 395 |
| Massachusetts | 6,467 | 2 | 9 | ........ | 3 | 942 | 499 | ...... | 1,444 |
| Michigan | 3,248 | 106 | 13 | ........ | 32 | 90 | 31 | ...... | 153 |
| Minnesota | 1,732 | ........ | 3 | ........ | 1 | 90 | 1 | ...... | 92 |
| Mississippi | 118 | ........ | ........ | ........ | 1 | 82 | 2 | ...... | 85 |
| Missouri | 1.828 | 32 | 1 | ........ | 2,365 | 234 | 43 | ...... | 2,642 |
| Montana | 189 | ........ | 1 | ........ | ........ | 75 | ........ | ...... | 75 |
| Nebraska | 492 | ........ | ........ | ........ | 10 | 158 | 1,000 | ...... | 1,168 |
| Nevada | 2 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| New Hampshire | 354 | ........ | ........ | ........ | ........ | ........ | 310 | ...... | 310 |
| New Jersey | 6,155 | 8 | 159 | ........ | 43 | 15,538 | 639 | 302 | 16,522 |
| New Mexico | 12 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| New York | 39,083 | 565 | 230 | 7 | 4,362 | 8,344 | 608 | 315 | 13,629 |
| North Carolina | 451 | 20 | 1 | ........ | ........ | 168 | 265 | ...... | 433 |
| North Dakota | 51 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Ohio | 6,915 | 89 | 116 | 2 | 4 | 1,301 | 272 | ...... | 1,577 |
| Oklahoma | 260 | 3 | ........ | ........ | 345 | ........ | ........ | ...... | 345 |
| Oregon | 971 | ........ | 2 | ........ | 735 | 87 | 200 | ...... | 1,022 |
| Pennsylvania | 19,699 | 72 | 28 | 1 | 4,992 | 11,231 | 7,254 | 13 | 23,490 |
| Rhode Island | 1,065 | ........ | 3 | ........ | ........ | 8 | ........ | ...... | 8 |
| South Carolina | 283 | ........ | ........ | ........ | ........ | ........ | 2 | ...... | 2 |
| South Dakota | 74 | 4 | ........ | ........ | ........ | ........ | 10 | ...... | 10 |
| Tennessee | 1,098 | 15 | 1 | ........ | ........ | 420 | 300 | 100 | 820 |
| Texas | 1,100 | 3 | ........ | ........ | ........ | 218 | 21 | ...... | 239 |
| Utah | 223 | 2 | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Vermont | 273 | ........ | ........ | ........ | ........ | ........ | 200 | ...... | 200 |
| Virginia | 1,535 | 1 | 2 | ........ | ........ | 318 | ........ | ...... | 318 |
| Washington | 1,184 | 7 | ........ | ........ | 734 | 84 | 50 | ...... | 868 |
| West Virginia | 406 | ........ | ........ | ........ | 3 | ........ | 1 | ...... | 4 |
| Wisconsin | 2,601 | 1 | 4 | ........ | 5 | 84 | 50 | ...... | 139 |
| Wyoming | 8 | ........ | ........ | ........ | ........ | ........ | ........ | ...... | ........ |
| Exported by permittees | 350 | ........ | 1 | ........ | ........ | 990 | ........ | ...... | 990 |
| Total | 141,113 | 1,297 | 823 | 11 | 44,563 | 64,177 | 19,164 | 913 | 128,817 |

The record of entry under special permits of restricted plants under regulation 14 for the purpose of keeping the country supplied with new varieties and necessary propagating stock and to meet any other technical or research need is given in the following table. During the fiscal year 1922, 750 such special permits were issued, covering the entry of 9,573,199 plants and bulbs. Importations have already been made under 518 of these special permits of 3,344,026 plants and bulbs. In addition to the record for 1922, data for the three years during which the quarantine has been in effect are included. It will be noted that during the three years a total of 11,344 varieties of plants has been under consideration, of which 10,115, or 89.1 per cent, have been approved for entry. The discrepancy between the numbers of plants authorized and the numbers imported is due largely to the fact that the permittees have not been able to secure abroad the quantities of plants which they have been authorized to import. In many instances such permits were reissued the year following. In this connection it should be remembered that these special permits are issued for new varieties and stock unavailable in the United States and the permittees asked for all they hoped to get, but very naturally such material is often limited as to quantity in the country of origin. A considerable percentage of the permits issued during the last fiscal year have been renewed for the present year where the importer was unable to secure his material and make his importations under the original permit. All special permits, except for orchids, are terminated at the end of the fiscal year (June 30) and reissued if necessary. In the case of orchid permits, these are valid through the calendar year.

*Special permit importations, fiscal year 1922, with combined totals for 1920, 1921, and 1922.*

| Name. | Fiscal year 1922. | | | | Grand totals, 1920, 1921, and 1922. | | | |
|---|---|---|---|---|---|---|---|---|
| | Permits issued. | | Permits imported. | | Permits issued. | | Permits imported. | |
| | Number. | Quantity. | Number. | Quantity. | Number. | Quantity. | Number. | Quantity. |
| Gladioli | 95 | 2,611,259 | 62 | 1,262,391 | 352 | 18,178,247 | 243 | 7,657,605 |
| Dahlias | 62 | 3,209 | 47 | 1,880 | 143 | 11,209 | 104 | 6,516 |
| Iris | 189 | 2,573,248 | 108 | 605,881 | 321 | 9,232,115 | 189 | 4,787,642 |
| Peonies | 103 | 383,135 | 80 | 56,294 | 202 | 540,540 | 128 | 96,570 |
| Other bulbs, rhizomes, and roots | 91 | 2,327,405 | 47 | 684,869 | 185 | 3,753,491 | 102 | 1,299,641 |
| Ornamentals | 99 | 544,747 | 72 | 487,851 | 215 | 1,161,266 | 123 | 679,475 |
| Roses | 84 | 13,041 | 55 | 7,973 | 165 | 57,674 | 109 | 44,894 |
| Orchids | 50 | 8,194 | 44 | 7,013 | 142 | 40,172 | 109 | 18,108 |
| Herb plants | 112 | 1,106,414 | 53 | 229,718 | 185 | 1,312,868 | 92 | 370,122 |
| Fruits | 9 | 2,547 | 4 | 156 | 21 | 3,474 | 7 | 282 |
| Total | ...... | 9,573,199 | ...... | 3,344,026 | ...... | 34,291,056 | ...... | 14,960,855 |

*Summary for the years 1920, 1921, and 1922.*

| Fiscal year. | Permits issued. | | Permits imported. | |
|---|---|---|---|---|
| | Number. | Quantity. | Number. | Quantity. |
| 1920 | 311 | 10,752,844 | 171 | 3,484,195 |
| 1921 | 622 | 13,965,013 | 411 | 8,132,634 |
| 1922 | 750 | 9,573,199 | 518 | 3,344,026 |
| Grand total | 1,683 | 34,291,056 | 1,100 | 14,960,855 |

### IMPORTATIONS OF OTHER RESTRICTED PLANT PRODUCTS.

In addition to the foregoing record of importations of plants and plant products for propagation, the board has supervised the importation under quarantine of 11,951 sacks of potatoes, chiefly from Denmark and Mexico; 40,682 boxes of oranges, chiefly from Japan; 26,067 barrels of horseradish to insure freedom from earth; 1,741 bales of brooms and 6,696 bales of broom corn, both of which latter have been sterilized with steam. The board has also supervised and safeguarded the importation for immediate exportation in bond to other countries of considerable quantities of prohibited or restricted plants and plant products.

The enforcement of quarantine No. 49, on account of the black fly, has brought under restriction and regulation practically all fruit and vegetable importations from Cuba, the Bahamas, Jamaica, Canal Zone, Costa Rica, India, Philippine Islands, Ceylon, and Java. The records of importations for the year are given in the following tables:

*Fruits and vegetables imported under quarantine No. 49 during fiscal year ending June 30, 1922, by countries of origin.*

| Kind. | Bahamas. | Canal Zone. | Costa Rica. | Cuba. | Jamaica. | Total. |
|---|---|---|---|---|---|---|
| Avocadoes.........crates.. | 10 | | | 46,614 | 12 | 46,636 |
| Bananas.........bunches.. | 152 | 331,256 | 3,692,507 | 1,983,307 | 10,647,059 | 16,654,281 |
| Cassava.........crates.. | | | | 605 | | 605 |
| Coconuts.........number.. | 25,790 | 15,740,326 | 34,110 | 1,660,734 | 16,315,276 | 33,776,236 |
| Eggplants.........crates.. | | | | 52,856 | | 52,856 |
| Figs.........do.... | | | | | 592 | 592 |
| Grape fruits.........do.... | 70 | | 126 | 184,027 | 2,758 | 186,981 |
| Lima beans.........do.... | | | | 6,885 | | 6,885 |
| Limes.........do.... | | | 311 | 549 | 84 | 944 |
| Malangas.........do.... | | | | 1,022 | 1 | 1,023 |
| Mammeas.........do.... | 4 | | | 1,963 | | 1,967 |
| Mangoes.........do.... | | | | 5,528 | 511 | 6,039 |
| Okra.........do.... | | | | 6,133 | 1 | 6,134 |
| Onions.........do.... | | | | 4,000 | 2 | 4,002 |
| Oranges.........do.... | | 2 | 1,132 | 4,989 | 3,206 | 9,329 |
| Peppers.........do.... | 7 | | 23 | 108,241 | 6,155 | 114,426 |
| Pineapples.........do.... | 3,513 | | 11,340 | 1,051,051 | 14 | 1,065,918 |
| Plantains.........do.... | 2 | 8,975 | 391 | 65,764 | 149 | 75,281 |
| Potatoes.........sacks.. | | | | 300 | | 300 |
| Pumpkins.........number.. | 165 | | | 267 | 20 | 452 |
| Sapodillas.........crates.. | 783 | | | 28 | | 811 |
| Squash.........do.... | 2 | | | 925 | | 927 |
| Tomatoes.........do.... | 103,287 | | | 97,565 | | 200,852 |
| Watermelons.........number.. | 30 | | | 6 | | 36 |
| Not specified.........crates.. | | 100 | | 823 | 1 | 924 |
| Miscellaneous: | | | | | | |
| Fruits.........do.... | 7 | | 4 | 645 | | 656 |
| Vegetables.........do.... | 37 | 27 | | 245 | 7 | 316 |

*Fruits and vegetables imported under quarantine No. 49 during fiscal year ending June 30, 1922, by ports of entry.*

| Kind. | Baltimore, Md. | Boston, Mass. | Key West, Fla. | Miami, Fla. | New Orleans, La. | New York, N. Y. | Philadelphia, Pa. | Tampa, Fla. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Avocadoes......crates.. | ........ | 5 | 17,881 | 10 | 13,602 | 7,468 | 2 | 7,668 | 46,636 |
| Bananas......bunches.. | 2,880,450 | 1,705,101 | 3,148 | 42,924 | 868,963 | 8,377,568 | 2,758,958 | 17,169 | 16,654,281 |
| Cassava.........crates.. | ........ | ........ | 505 | ........ | ........ | 60 | ........ | 40 | 605 |
| Coconuts .....number.. | 1,117,900 | 108,300 | 1,264 | 37,790 | 263,200 | 30,350,282 | 1,872,500 | 15,000 | 33,776,236 |
| Eggplants.......crates.. | ........ | ........ | 2 | ........ | 4,401 | 48,453 | ........ | ........ | 52,856 |
| Figs.............do.... | ........ | 2 | ........ | ........ | ........ | 590 | ........ | ........ | 592 |
| Grapefruit.......do.... | 333 | 344 | 61,710 | ........ | 7,485 | 117,105 | 4 | ........ | 186,981 |
| Lima beans.......do.... | ........ | ........ | ........ | ........ | ........ | 6,885 | ........ | ........ | 6,885 |
| Limes............do.... | ........ | 23 | 17 | ........ | 230 | 636 | ........ | 38 | 944 |
| Malangas.........do.... | ........ | ........ | 388 | ........ | ........ | 335 | ........ | 300 | 1,023 |
| Mammeas.........do.... | ........ | ........ | 420 | 4 | 272 | ........ | ........ | 1,271 | 1,967 |
| Mangoes..........do.... | ........ | ........ | 50 | ........ | 4,911 | 1,077 | 1 | ........ | 6,039 |
| Okra.............do.... | ........ | ........ | 176 | ........ | 2,647 | 3,158 | ........ | 153 | 6,134 |
| Onions...........do.... | ........ | ........ | ........ | ........ | ........ | 3,902 | ........ | 100 | 4,002 |
| Oranges..........do.... | 1,471 | 295 | 4,555 | ........ | ........ | 2,988 | ........ | 20 | 9,329 |
| Peppers .........do.... | ........ | ........ | 605 | 7 | 2,258 | 111,427 | ........ | 129 | 114,426 |
| Pineapples.......do.... | ........ | 2,773 | 808,661 | 1,679 | 18,456 | 232,083 | ........ | 2,266 | 1,065,918 |
| Plantains........do.... | ........ | 503 | 20,445 | 9,702 | ........ | 36,085 | 1 | 8,545 | 75,281 |
| Potatoes.........sacks.. | ........ | ........ | 300 | ........ | ........ | ........ | ........ | ........ | 300 |
| Pumpkins....number.. | ........ | ........ | 153 | 165 | ........ | 36 | ........ | 98 | 452 |
| Sapodillas......crates.. | ........ | ........ | 7 | 783 | ........ | ........ | ........ | 21 | 811 |
| Squash...........do.... | ........ | ........ | ........ | 2 | 7 | 918 | ........ | ........ | 927 |
| Tomatoes.........do.... | ........ | ........ | 22,976 | 36,206 | 39,318 | 102,117 | ........ | 235 | 200,852 |
| Watermelons..number.. | ........ | ........ | 6 | 30 | ........ | ........ | ........ | ........ | 36 |
| Not specified....crates.. | ........ | ........ | 1 | ........ | ........ | 922 | 1 | ........ | 924 |
| Miscellaneous: | | | | | | | | | |
| Fruits.........do.... | ........ | 4 | 307 | 7 | 53 | 95 | ........ | 190 | 656 |
| Vegetables...do.... | ........ | 27 | 100 | 37 | 17 | 132 | ........ | 3 | 316 |

## PORT-INSPECTION SERVICE.

This service is the first line of defense and represents a very important and rapidly growing activity. The enforcement of foreign quarantines must primarily be carried out at the ports of entry of the United States. It involves the inspection, in cooperation with customs officers, of vessels arriving from foreign countries for the purpose of excluding plant pests with plant material brought as cargo of such vessels or by passengers or crews. In the case of Mexico, it involves the control of freight and other traffic between that Republic and the United States, and control to a much less extent on the Canadian border.

Two States, California and Florida, on account of their very important fruit interests, are giving most valuable cooperation and aid in such port-inspection work. The State of California is spending in this work approximately $100,000 a year to protect her great fruit industry, and by collaboration this department gets the advantage of this work at trifling cost. Florida is in a similar status. No other States are taking this kind of action, and the protection at the other ports of the United States is practically limited to work of the Federal Horticultural Board.

The importance of this work may be illustrated by the following typical instance: The examination of the personal baggage of a passenger landing at Baltimore from Brazil disclosed in one of his boxes some fifty-odd packages of Brazilian cotton seed all infested with living pink bollworms. The owner proposed to take the material to the cotton section of Mississippi for planting. Had there been no inspector at Baltimore, this entry would probably have resulted in the establishment in Mississippi and in the South of the worst known enemy of cotton, and would possibly have nullified all the effort which has been going on now for several years at great cost to control and eradicate this pest in its present rather limited foothold in Louisiana, Texas, and New Mexico. This is only one illustration of hundreds during the year of the interception of pests threatening many of the major fruit and field crops of the Nation. These interceptions have included such important pests as the corn borer, citrus canker, pink bollworm, various fruit flies (including the Mediterranean), potato weevils, and many others of both known and unknown possibilities. A total of 397 different kinds of insect pests have been thus intercepted and identified, together with 175 others the specific identification of which it has not been possible to make. A complete list of the insects intercepted on foreign plants and plant products during 1921 is given in the annual letter of information on such interceptions published for that year.

In connection with this inspection of imported plants and plant products it is very important that provision be made for cooperation with the Post Office Department for the examination of parcel-post packages from abroad. The postal inspectors are not trained to make such inspections, and such parcels very frequently have been found to contain the very pests which the department is making a valiant effort to exclude from this country or exterminate, and inasmuch as such parcels may go directly to the interior points for customs examination and distribution they present an exceptional menace. There are some 25 border and interior points for the examination of such parcel-post packages in the United States. The board now has inspectors, in connection with other port duties, at only 11 of these points.

Outside of the collaborative service in California and Florida referred to above, the port inspection service as now being conducted covers particularly the ports of Baltimore, Boston, New Orleans, Philadelphia, Portland, and Seattle, and involves the inspection of the ocean commerce entering these ports.

This service is very inadequate and undermanned at all of the ports listed and long hours of duty are involved, and even then only partial inspection can be made and other important ports are without any protection of this sort whatsoever.

To enable the board to adequately extend and properly conduct this service and to cooperate with the Postal Service at points where no department inspectors are now stationed, the board requested an increase of $100,000. This sum was looked upon as a minimum, but was reduced to $60,000 on the score of economy. Protection of this sort is work of a continuing nature and must be carried out efficiently and adequately, and is, therefore, on a different basis from work which may be postponed or materially reduced to be resumed later. In other words, a single introduction such as the specific example given above would cost the country hundreds of millions of dollars. The likelihood of such introductions can be largely eliminated if adequate inspection is made possible.

An additional very important feature of the inspection service of the board is the inspection at the quarantine house of the department of plant materials imported from all quarters of the world under special permits, and also the importations of new plants and seeds made by the department. In connection with this work a total of 12,732 shipments of plants and plant products were examined by the local inspection service of the board. Of this number 426 represented special plant introduction importations under the provision of quarantine No. 37. The others represented departmental importations or inspection and certification of plants and plant products of domestic origin arriving in or leaving the District of Columbia.

### TERMINAL INSPECTION OF MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS.

During the year Utah instituted terminal inspection of mail shipments of plants and plant products authorized by the act of March 4, 1915, and the terminal inspection stations in California and Mississippi were revised. California, Arizona, Montana, Florida, Washington, Arkansas, the District of Columbia, Mississippi, and the Territory of Hawaii had previously, in the order named, taken advantage of the provisions of the act referred to. Such terminal inspection is conducted entirely at the expense of the States concerned and has proved to be an important adjunct to the efforts of this board in enforcing its domestic quarantines.

### CONVICTIONS FOR VIOLATIONS OF THE PLANT QUARANTINE ACT.

During the past year the solicitor of the department reported the conviction of 19 shippers for violations of the plant quarantine act, 14 in regard to the white pine blister rust quarantine, 2 in regard to the avocado or alligator pear quarantine, 1 in regard to the sweet potato and yam quarantine, 1 in regard to the gipsy moth and brown-tail moth quarantine, and 1 in regard to the sugar-cane quarantine (foreign). Fines aggregating $437 and costs were imposed.

### NEW AND REVISED PLANT QUARANTINES.

The following quarantines and other restrictive orders were either promulgated or revised since July 1, 1921, to the date of the preparation of this report, October 1, 1922:

*Domestic quarantines.*—Quarantine No. 51, restricting the movement from the United States into Hawaii of sugar cane, corn, cotton, alfalfa, and fruits of avocado and papaya, promulgated July 22, 1921; the pink bollworm quarantine, revised August 19, 1921, amended October 24, 1921, and again revised March 31, 1922; the European corn borer quarantine (domestic), revised October 29, 1921, and April 7, 1922, amended July 28, 1922, and September 2, 1922; the European corn borer quarantine (foreign), revised July 8, 1921; the gipsy moth and brown-tail moth quarantine, amended December 23, 1921, and June 15, 1922; the Japanese beetle quarantine, revised November 28, 1921; the satin moth quarantine, promulgated December 28, 1921; and the white pine blister rust quarantine (covering the State of Washington), promulgated March 1, 1922.

*Other restrictive orders.*—Regulations governing the importation of potatoes into the United States, revised February 28, 1922, and amended June 19, 1922.

A complete list of the current domestic and foreign quarantines and other restrictive orders follows:

## LIST OF CURRENT QUARANTINE AND OTHER RESTRICTIVE ORDERS

### QUARANTINE ORDERS.

The numbers assigned to these quarantines indicate merely the chronological order of issuance of both domestic and foreign quarantines in one numerical series. The quarantine numbers missing in this list are quarantines which have either been superseded or revoked. For convenience of reference these quarantines are here classified as domestic and foreign.

### DOMESTIC QUARANTINES.

*Date palms.*—Quarantine No. 6: Regulates the interstate movement of date palms or date-palm offshoots from Riverside County, Calif., east of the San Bernardino meridian; Imperial County, Calif.; Yuma, Maricopa, and Pinal Counties, Ariz.; and Webb County, Tex.; on account of the Parlatoria scale (*Parlatoria blanchardi*) and the Phoenicococcus scale (*Phoenicococcus marlatti*).

*Hawaiian fruits.*—Quarantine No. 13, revised: Prohibits or regulates the importations from Hawaii of all fruits or vegetables, in the natural or raw state, on account of the Mediterranean fruit fly and the melon fly.

*Sugar cane.*—Quarantine No. 16: Prohibits the importation from Hawaii and Porto Rico of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases.

*Five-leafed pines, Ribes and Grossularia.*—Quarantine No. 26, as amended: Prohibits the interstate movement of five-leafed pines, currant and gooseberry plants from all States east of and including the States of Minnesota, Iowa, Missouri, Arkansas, and Louisiana to points outside of this area; prohibits further (1) the interstate movement of five-leafed pines and black-currant plants to points outside the area comprising the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York, and, (2) to protect the State of New York, the movement from the New England States, on account of the white-pine blister rust.

*Sweet potato and yam.*—Quarantine No. 30: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of all varieties of sweet potatoes and yams (*Ipomoea batatas* and *Dioscorea* spp.), regardless of the use for which the same are intended, on account of the sweet-potato weevil (*Cylas formicarius*) and the sweet-potato scarabee (*Euscepes batatæ*).

*Banana plants.*—Quarantine No. 32: Prohibits the movement from the Territories of Hawaii and Porto Rico into or through any other Territory, State, or District of the United States of any species or variety of banana plants (*Musa* spp.), regardless of the use for which the same are intended, on account of two injurious weevils, (*Rhabdocnemis obscurus*) and (*Metamasius hemipterus*).

*Black stem rust.*—Quarantine No. 38: Prohibits the movement interstate to any point outside of the quarantined area of the common barberry and its horticultural varieties, as well as certain other species of Berberis and Mahonia, on account of the black stem rust of wheat, oats, barley, rye, and many wild and cultivated grasses.

*European corn borer.*—Quarantine No. 43 (second revision): Regulates the movement interstate to any point outside of the quarantined area of (1) corn and broom corn (including all parts of the stalk), all sorghums, sudan grass, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw as such or when used as packing, cut flowers or entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, and cut flowers or entire plants of gladiolus and dahlia, except the bulbs thereof, without stems, from infested areas in Massachusetts and New Hampshire, and (2) corn and broom corn (including all parts of the stalk), all sorghums, and sudan grass from infested areas in New York, Pennsylvania, Ohio, and Michigan on account of the European corn borer (*Pyrausta nubilalis*).

*Gipsy moth and brown-tail moth.*—Quarantine No. 45, as amended: Regulates the movement interstate to any point outside of the quarantined towns and territory, or from points in the generally infested area to points in the lightly infested area, of stone or quarry products, and of the plants and the plant products listed therein. The quarantine covers all the New England States.

*Hawaiian and Porto Rican cotton, cotton seed, and cottonseed products.*—Quarantine No. 47: Regulates the movement of cotton, cotton seed, and cottonseed products from Hawaii and Porto Rico on account of the pink bollworm and the cotton blister mite, respectively.

*Japanese beetle.*—Quarantine No. 48, revised: Regulates the movement interstate to any point outside of certain portions of the counties of Burlington, Gloucester, and

Camden, N. J., and certain portions of the counties of Philadelphia, Montgomery, and Bucks, Pa., of the following articles from the heavily infested area: (1) Sweet, green, or sugar corn, grapes, lettuce, cabbage, and forage crops of all kinds, including hay and straw; (2) nursery, ornamental, and greenhouse stock, and all other plants, except bulbs and cut flowers; and (3) soil, compost, and manure other than fresh manure; and from the lightly infested area, (1) nursery, ornamental, and greenhouse stock and all other plants except bulbs and cut flowers; and (2) soil, compost, and manure other than fresh manure, on account of the Japanese beetle (*Popillia japonica*).

*United States quarantined to protect Hawaii.*—Quarantine No. 51: Regulates the movement from the United States to the Territory of Hawaii, as ships' stores or as baggage or effects of passengers or crews, of sugar cane, corn, cotton, alfalfa, and the fruits of the avocado and papaya.

*Pink bollworm.*—Quarantine No. 52, with revised rules and regulations: Prohibits the interstate movement from the infested and regulated areas of Texas, Louisiana, and New Mexico of cotton, including all parts of the plant, seed cotton, cotton lint, linters, gin waste, and all other forms of cotton lint, cotton seed, cottonseed hulls, cottonseed cake and meal, bagging and other containers of the articles enumerated, and also railway cars, boats, and other vehicles which have been used in conveying cotton and cotton products grown in the infested districts or which are fouled with such products, hay and other farm products, farm household goods, and farm equipment, except as provided in the rules and regulations supplemental thereto, on account of the pink bollworm of cotton (*Pectinophora gossypiella* Saunders).

*Satin moth.*—Quarantine No. 53: Prohibits the interstate movement to points outside of the infested areas in New Hampshire and Massachusetts of all species or varieties of poplar and willow, on account of the satin moth (*Stilpnotia salicis* L.).

*White-pine blister rust.*—Quarantine No. 54: Prohibits the interstate movement from all counties in the State of Washington lying west of the crest of the Cascade Mountains of five-leafed pines, currant and gooseberry plants, on account of the white-pine blister rust.

## FOREIGN QUARANTINES.

*Irish potatoes.*—Quarantine No. 3: Prohibits the importation of the common or Irish potato from Newfoundland; the islands of St. Pierre and Miquelon; Great Britain, including England, Scotland, Wales, and Ireland; Germany; and Austria-Hungary, on account of the disease known as potato wart.

*Mexican fruits.*—Quarantine No. 5, as amended: Prohibits the importation of oranges, sweet limes, grapefruit, mangoes, achras sapotes, peaches, guavas, and plums from the Republic of Mexico, on account of the Mexican fruit fly.

*Five-leafed pines, Ribes and Grossularia.*—Quarantine No. 7, as amended: Prohibits the importation from each and every country of Europe and Asia, and from the Dominion of Canada and Newfoundland, of all five-leafed pines and all species and varieties of the genera *Ribes* and *Grossularia*, on account of the white-pine blister rust.

*Cotton seed and cottonseed hulls.*—Quarantine No. 8, as amended: Prohibits the importation from any foreign locality and country, excepting only the locality of the Imperial Valley, in the State of Lower California, Mexico, of cotton seed (including seed cotton) of all species and varieties, and cottonseed hulls, on account of the pink bollworm. Cotton and cotton seed from the Imperial Valley may be entered under permit and regulation.

*Seeds of avocado or alligator pear.*—Quarantine No. 12: Prohibits the importation from Mexico and the countries of Central America of the seeds of the avocado or alligator pear on account of the avocado weevil.

*Sugar cane.*—Quarantine No. 15: Prohibits the importation from all foreign countries of living canes of sugar cane, or cuttings or parts thereof, on account of certain injurious insects and fungous diseases. There are no restrictions on the entry of such materials into Hawaii and Porto Rico.

*Citrus nursery stock.*—Quarantine No. 19: Prohibits the importation from all foreign localities and countries of all citrus nursery stock, including buds, scions, and seeds, on account of the citrus canker and other dangerous citrus diseases. The term "citrus," as used in this quarantine, includes all plants belonging to the subfamily or tribe *Citratae.*

*European Pines.*—Quarantine No. 20: Prohibits, on account of the European pine-shoot moth (*Evetria buoliana*), the importation from all European countries and localities of all pines not already excluded by Quarantine No. 7.

*Indian corn or maize and related plants.*—Quarantine No. 24, as amended: Prohibits the importation from southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceania, Philippine Islands, Formosa, Japan, and adjacent islands, in the raw or unmanufactured state, of seed and all other portions of Indian corn or maize (*Zea mays L.*), and the closely related plants, including all species of Teosinte (*Euchlaena*), Job's tears (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*, on account of the downy mildews and *Physoderma* diseases of Indian corn, except that Indian corn or maize may be imported under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

*Citrus fruit.*—Quarantine No. 28: Prohibits the importation from eastern and southeastern Asia (including India, Siam, Indo-China, and China), the Malayan Archipelago, the Philippine Islands, Oceania (except Australia, Tasmania, and New Zealand), Japan (including Formosa and other islands adjacent to Japan), and the Union of South Africa, of all species and varieties of citrus fruits, on account of the citrus canker, except that oranges of the mandarin class (including satsuma and tangerine varieties) may be imported under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

*Sweet potato and yam.*—Quaratine No. 29: Prohibits the importation for any purpose of any variety of sweet potatoes or yams (*Ipomoea batatas* and *Dioscorea* spp.) from all foreign countries and localities, on account of the sweet-potato weevils (*Cylas* spp.) and the sweet-potato scarabee (*Euscepes batatae*).

*Banana plants.*—Quarantine No. 31: Prohibits the importation for any purpose of any species or variety of banana plants (*Musa* spp.), or portions thereof, from all foreign countries and localities, on account of the banana-root borer (*Cosmopolites sordidus*). No restrictions are placed on the importation of the fruit of the banana.

*Bamboo.*—Quarantine No 34: Prohibits the importation for any purpose of any variety of bamboo seed, plants, or cuttings thereof capable of propagation, including all genera and species of the tribe *Bambuseae*, from all foreign countries and localities, on account of dangerous plant diseases, including the bamboo smut (*Ustilago shiraiana*). This quarantine order does not apply to bamboo timber consisting of the mature dried culms or canes which are imported for fishing rods, furniture making, or other purposes, or to any kind of article manufactured from bamboo or to bamboo shoots cooked or otherwise preserved.

*Nursery stock, plants, and seeds.*—Quarantine No. 37, with regulations, revised: Prohibits the importation of nursery stock and other plants and seeds from all foreign countries and localities, on account of certain injurious insects and fungous diseases, except as provided in the regulations. Under this quarantine the following plants and plant products may be imported without restriction: Fruits, vegetables, cereals, and other plant products imported for medicinal, food, or manufacturing purposes and field, vegetable, and flower seeds. The entry of the following plants is permitted under permit: Lily bulbs, lily of the valley, narcissus, hyacinths, tulips, and crocus; stocks, cuttings, scions, and buds of fruits; rose stocks, including manetti, multiflora, brier rose, and rosa rugosa; nuts, including palm seeds, seeds of fruit, forest, ornamental, and shade trees; seeds of deciduous and evergreen ornamental shrubs, and seeds of hardy perennial plants.

Provision is also made for the issuance of special permits under safeguards to be prescribed in such permits for the entry in limited quantities of nursery stock and other plants and seeds not covered in the preceding lists for the purpose of keeping the country supplied with new varieties and necessary propagating stock.

*Flag smut and take-all.*—Quarantine No. 39, with regulations: Prohibits the importation of seed or paddy rice from Australia, India, Japan, Italy, France, Germany, Belgium, Great Britain, Ireland, and Brazil on account of two dangerous plant diseases known as flag smut (*Urocystis tritici*) and take-all (*Ophiobolus graminis*). Wheat, oats, barley, and rye may be imported from the countries named only under permit and upon compliance with the conditions prescribed in the regulations of the Secretary of Agriculture.

*European corn borer.*—Quarantine No. 41, with regulations, revised: Prohibits the importation of the stalk and all other parts, whether used for packing or other purposes, in the raw or unmanufactured state, of Indian corn or maize, broom corn, sweet sorghums, grain sorghums, Sudan grass, Johnson grass, sugar cane, pearl millet, napier grass, teosinte, and Job's tears, from all foreign countries and localities, except as provided in the rules and regulations supplemental thereto, on account of the European corn borer (*Pyrausta nubilalis*) and other dangerous insects and plant diseases.

*Mexican corn.*—Quarantine No. 42, with regulations: Prohibits the importation of Indian corn or maize from Mexico, except as provided in the rules and regulations supplemental thereto, on account of the contamination of such corn with cotton seed more or less infested with the pink bollworm.

*Stocks, cuttings, scions, and buds of fruits.*—Quarantine No. 44: Prohibits the importation of stocks, cuttings, scions, and buds of fruits from Asia, Japan, Philippine

Islands and Oceania (including Australia and New Zealand) on account of dangerous plant diseases, including Japanese apple cankers, blister blight, and rusts, and injurious insect pests, including the oriental fruit moth, the pear fruit borer, the apple moth, etc.

*Citrus black fly.*—Quarantine No. 49, with regulations: Prohibits the importation of fruits and vegetables, and of plants or portions of plants used as packing material in connection with shipments of such fruits and vegetables, or otherwise, from Cuba, the Bahamas, Jamaica, Canal Zone, Costa Rica, India, Philippine Islands, Ceylon, and Java, except as provided in the rules and regulations supplemental thereto, on account of the citrus black fly (*Aleurocanthus woglumi*).

### OTHER RESTRICTIVE ORDERS.

The regulation of the entry of nursery stock from foreign countries into the United States was specifically provided for in the plant quarantine act. The act further provides for the similar regulation of any other class of plants or plant products when the need therefor shall be determined. The entry of the plants and plant products listed below has been brought under such regulation:

*Nursery stock.*—The conditions governing the entry of nursery stock and other plants and seeds from all foreign countries and localities are indicated above under "Foreign quarantines." (See quarantine No. 37, revised.)

*Irish potatoes.*—The importation of Irish potatoes is prohibited altogether from the countries enumerated in the potato quarantine. Potatoes may be admitted from other foreign countries under permit and in accordance with the provisions of the regulations issued under order of December 22, 1913, bringing the entry of potatoes under restriction on account of injurious potato diseases and insect pests. Importation of potatoes is now authorized from the following countries: Denmark, Cuba, Bermuda, and the Dominion of Canada; also from the States of Chihuahua and Sonora, and the Imperial Valley in Lower California, Mexico. The regulations issued under this order have been amended so as to permit, free of any restrictions whatsoever under the plant quarantine act, the importation of potatoes from any foreign country into the Territories of Porto Rico and Hawaii for local use only and from the Dominion of Canada and Bermuda into the United States or any of its Territories or Districts.

*Avocado, or alligator pear.*—The order of February 27, 1914, prohibits the importation from Mexico and the countries of Central America of the fruits of the avocado, or alligator pear, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of the avocado weevil. Entry is permitted through the port of New York only and is limited to the large, thick-skinned variety of the avocado. The importation of the small, purple, thin-skinned variety of the fruit of the avocado and of avocado nursery stock under 18 months of age, is prohibited.

*Cotton.*—The order of April 27, 1915, prohibits the importation of cotton from all foreign countries and localities, except under permit and in accordance with the other provisions of the regulations issued under said order, on account of injurious insects, including the pink bollworm. These regulations apply in part to cotton grown in and imported from the Imperial Valley, in the State of Lower California, Mexico.

*Cottonseed products.*—The order of June 23, 1917, prohibits the importation of cottonseed cake, meal, and all other cottonseed products, except oil, from all foreign countries, and a second order of June 23, 1917, prohibits the importation of cottonseed oil from Mexico, except under permit and in accordance with the other provisions of the regulations issued under said orders, on account of injurious insects, including the pink bollworm.

# REPORT OF THE OFFICE OF EXHIBITS.

United States Department of Agriculture,
Office of Exhibits,
*Washington, D. C., September 12, 1922.*

Sir: I submit herewith the report of the work of the Office of Exhibits for the fiscal year ended June 30, 1922.

Respectfully,

Joseph W. Hiscox,
*In Charge of Exhibits.*

Hon. Henry C. Wallace,
*Secretary of Agriculture.*

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During the fiscal year 1922 the exhibit work was transferred to the office of the Secretary, the officer in charge of exhibits reporting directly to the Assistant Secretary of Agriculture. This change became effective November 16, 1921.

Department exhibits were shown during the year at 60 fairs and expositions held in 39 States and in the District of Columbia, with a total attendance of over 4,000,000. Approximately 121,900 square feet of floor space were used for exhibit purposes. Sixteen applications for exhibits were refused on account of lack of sufficient material, and in one or two instances because of conflicting dates.

Exhibits were routed on circuits where possible, and 31 department representatives from the following bureaus accompanied them and conducted their presentation and display: Bureau of Agricultural Economics, Bureau of Soils, Bureau of Public Roads, Bureau of Animal Industry, Forest Service, States Relations Service, Bureau of Biological Survey, and Weather Bureau.

Following is a list of the cities at which exhibits were made:

*Cities at which exhibits were held during fiscal year ended June 30, 1922.*

DAIRY EXHIBITS.

| Place. | Date. | Occasion. |
|---|---|---|
| Waterloo, Iowa | Sept. 26 to Oct. 2 | Dairy Cattle Congress. |
| Hamline, Minn | Oct. 8–15 | National Dairy Show. |
| Portland, Oreg | Nov. 5–12 | Pacific International Live-Stock Exposition. |
| Stockton, Calif | Dec. 6–11 | California Dairy Council. |
| Madison, Wis | Jan. 30 to Feb. 4 | Wisconsin Dairy Show. |
| Saginaw, Mich | Feb. 14–17 | Michigan Dairy Show. |

LIVE-STOCK EXHIBITS.

| Place. | Date. | Occasion. |
|---|---|---|
| Springfield, Mass | Sept. 18–24 | Eastern States Exposition. |
| Chicago, Ill | Nov. 26 to Dec. 3 | International Live-Stock Exposition. |
| Ames, Iowa | Jan. 30 to Feb. 4 | Farmers' Week, Iowa State College. |

*Cities at which exhibits were held during fiscal year ended June 30, 1922*—Continued.

### POULTRY EXHIBITS.

| Place. | Date. | Occasion. |
|---|---|---|
| Kansas City, Mo | Nov. 29 to Dec. 4 | Heart of America Poultry Show. |
| Baltimore, Md | Dec. 6-10 | Baltimore Pigeon and Pet Stock. |
| Norfolk, Va | Jan. 3-7 | Old Dominion Poultry Show. |
| New York City | Jan. 25-29 | Madison Square Garden Poultry Show. |

### MISCELLANEOUS MAJOR EXHIBITS.

| | | |
|---|---|---|
| Baltimore, Md | July 11-16 | Marine Show, Export and Import Exposition. |
| Madison, Wis | Aug. 29 to Sept. 3 | Wisconsin State Fair. |
| Columbus, Ohio | do | Ohio State Fair. |
| Detroit, Mich | Sept. 2-11 | Michigan State Fair. |
| Timonium, Md | Sept. 5-10 | Maryland State Fair. |
| Chattanooga, Tenn | Sept. 17-24 | Chattanooga Interstate Fair. |
| Rochester, N. Y | Sept. 20-23 | Rochester Fair. |
| Richmond, Va | Oct. 1-8 | Virginia State Fair. |
| Greenville, S. C | Oct. 6-12 | Textile Products Show. |
| Cincinnati, Ohio | Oct. 15-22 | Cincinnati Pure Food Exposition. |
| Chicago, Ill | Oct. 17-22 | American Mining Congress. |
| Columbia, S. C | Oct. 24-28 | South Carolina State Fair. |
| Tallahassee, Fla | Nov. 12-19 | Florida State Fair. |
| Trenton, N. J | Jan. 9-14 | Farmers' Week. |
| College Park, Md | Jan. 10-12 | Maryland Sheep Growers' Association. |
| Louisville, Ky | Jan. 16-20 | National Canners' Association. |
| New Brunswick, N. J | Jan. 16-21 | New Jersey Agricultural College. |
| Grove City, Pa | Jan. 31 to Feb. 3 | Milk Show. |
| Washington, D. C | Feb. 6-18 | National Food Show and Household Exposition. |
| Madison, Wis | Apr. 18-23 | University of Wisconsin. |
| Washington, D. C | June 5-11 | National Wood Turners' Association. |
| Boston, Mass | June 22-24 | Tuberculosis Eradication Conference. |

### GENERAL AGRICULTURAL EXHIBITS.

| | | |
|---|---|---|
| Southeast circuit: | | |
| Wheeling, W. Va | Sept. 5-10 | West Virginia State Fair. |
| Nashville, Tenn | Sept. 19-24 | Tennessee State Fair. |
| Atlanta, Ga | Oct. 13-22 | Southeastern Fair. |
| Columbia, S. C | Oct. 24-28 | South Carolina State Fair |
| Central west circuit: | | |
| Sedalia, Mo | Aug. 8-20 | Missouri State Fair. |
| Milwaukee, Wis | Aug. 29 to Sept. 3 | Wisconsin State Fair. |
| Topeka, Kans | Sept. 12-17 | Kansas Free Fair. |
| Wichita, Kans | Sept. 26 to Oct. 8 | International Wheat Show. |
| Little Rock, Ark | Nov. 11-19 | Arkansas State Fair. |
| Stuttgart, Ark | Nov. 30 to Dec. 4 | Arkansas Rice Carnival. |
| Western district exhibits: | | |
| Helena, Mont | Sept. 12-17 | Montana State Fair. |
| Billings, Mont | Sept. 20-25 | Midland Empire Fair. |
| Spokane, Wash | Sept. 5-10 | Spokane Interstate Fair. |
| Douglas, Wyo | Sept. 13-16 | Wyoming State Fair. |
| Pueblo, Colo | Sept. 26-30 | Colorado State Fair. |
| Raton, N. Mex | Oct. 5-7 | Northern New Mexico Fair. |
| Elko, Nev | Sept. 15-17 | Elko Fair. |
| Boise, Idaho | Sept. 26 to Oct. 1 | Idaho State Fair. |
| Salt Lake City, Utah | Oct. 3-8 | Utah State Fair. |
| Sacramento, Calif | Sept. 3-11 | California State Fair. |
| Fresno, Calif | Sept. 30 to Oct. 4 | Fresno Fair. |
| Riverside, Calif | Oct. 7-11 | Southern California Fair. |
| Yakima, Wash | Sept. 20-25 | Washington State Fair. |
| Salem, Oreg | Sept. 26 | Oregon State Fair. |
| Portland, Oreg | Nov. 5-12 | Pacific International Live-Stock Expo tion. |

Exhibits for the State fairs were selected and prepared with a view to furnishing helpful information on agriculture to the people of the localities in which the exhibits were shown. Models, objects, charts, maps, pictures, and demonstrations were the principal mediums used in presenting the information. On the central and southeastern circuits market reports were received over radio receiving sets, installed as a part of the exhibit. This was one of the special features at the International Livestock Exposition, and numerous requests were made on the department's representatives for copies of this free daily service.

At the western district fairs exhibits were presented on the activities of the Forest Service, Biological Survey, Bureau of Public Roads, Bureau of Animal Industry, and Bureau of Agricultural Economics. These exhibits were conducted by western representatives of the three bureaus first named. Subjects from all the major bureaus were presented in the general agricultural exhibits. Representatives from various bureaus were detailed from Washington to conduct these exhibits. Comment from press and public was enthusiastically appreciative.

## EXHIBIT AT THE NATIONAL DAIRY SHOW.

Exhibits were prepared in booth form for the National Dairy Show. Composite pictorial, graphic, and word presentations were made on the walls of 23 of these booths of the various phases of dairy-cattle breeding, handling, and foreign marketing. The States Relations Service gave demonstrations of judging by the boys' and girls' clubs on a herd of live animals which the Bureau of Animal Industry furnished for the exhibit. The type of exhibit and method of presentation proved exceptionally successful, and requests have been received for its use at several places during the next fair season. The consensus of opinion was expressed in a letter by the secretary of a prominent association when he wrote: "That is a good way to put publicity into the hands of the people who will benefit most by it."

The most extensive of the special exhibits were shown at the National Dairy Show, at Hamline, Minn., and the International Livestock Exposition, at Chicago, Ill.

Previous to its display at the National Dairy Show a portion of this dairy exhibit was shown at the Dairy Cattle Congress at Waterloo, Iowa. Afterwards it went in whole or in part to the Pacific International Livestock Exposition at Portland, Oreg., the California Dairy Council at Stockton, Calif., the Wisconsin Dairy Show at Madison, Wis., and the Michigan Dairy Show at Saginaw, Mich.

Some of the booths prepared for the National Dairy Show, and particularly those on the use of milk, were later loaned for use in milk campaigns at Richmond, Va., Chattanooga, Tenn., Oshkosh, Wis., Columbus, Ohio, New Orleans, La., and Oklahoma City, Okla.

## INTERNATIONAL HAY AND GRAIN SHOW.

Eleven splendid booths similar in style to those prepared for the National Dairy Show, presenting livestock information from the Bureaus of Animal Industry, Agricultural Economics, Chemistry, Soils, Forest Service, and the States Relations Service were prepared for the International Hay and Grain Show in Chicago. A few models were also used. Many letters of commendation have been received from the presidents of agricultural colleges and prominent farmers and stockmen throughout the United States; also much favorable comment has appeared in the agricultural press.

At the Eastern States Exposition at Springfield, Mass., the department's exhibit featured boys' and girls' club activities of the States Relations Service, and 10 head of horses from the United States Morgan horse farm, Middlebury, Vt., were exhibited for the purpose of showing to the New England farmers the progress being made in the department's horse-breeding work.

In addition to the foregoing, exhibits on practically all subjects relating to agriculture were prepared or made available from exhibits on hand and sent to numerous points throughout the United States.

A radical departure has been made in the style of the presentation of information in exhibit form. So far as practicable single exhibits are confined in scope to single outstanding broad subjects, and the favor with which this method of presentation has been received, indicates that the course adopted is along progressive lines.

The department has developed a harmonious, attractive, forceful, and practical standard type of exhibits showing clearly and in concrete form the results of its investigational work. As a result educational institutions, agricultural associations, and kindred organizations are increasingly willing to share in the cost of presenting these exhibits to the public.

## BRAZILIAN INTERNATIONAL CENTENNIAL EXPOSITION.

The department's exhibit material prepared for the Brazilian International Centennial Exposition to be held in Rio de Janeiro, Brazil, September 7, 1922, to March 31, 1923, was finished and shipped on July 25, 1922. Six of the important bureaus of the department (Bureau of Public Roads, Bureau of Animal Industry, Weather Bureau, Forest Service, States Relations Service, and Bureau of Plant Industry) participated in the exhibits prepared under direction of this office. A carload and a half of material, designed to cover 4,000 square feet of floor space, was shipped south. The exhibit represents a careful selection of subjects with an eye to including only those relating to American farming which are of most interest to Brazilians. Large composite paintings, models, maps, illustrations, graphs, and specimens were used to show road construction in the United States, the livestock, naval-stores, and navel-orange industries, the gathering and distribution of weather information, educational facilities in agriculture and forestry, and our forestry resources.

The following reports were written and translated into Portuguese, and were printed for distribution at the exposition:

Forests and Forestry in the United States.
Livestock Industry of the United States.
The United States Forest Service.
The United States Weather Bureau.
The Study of Forestry.
Forest Products Laboratory.
The Bureau of Public Roads and its Exhibit.
Education and Research in Agriculture and Home Economics in the United States.

Twenty-one motion pictures on agricultural subjects were prepared by the department, to be shown daily in three auditoriums on the exposition grounds.

# ANNUAL REPORT OF THE ACTING DIRECTOR OF THE FIXED NITROGEN RESEARCH LABORATORY FOR THE FISCAL YEAR ENDED JUNE 30, 1922.

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United States Department of Agriculture,
Fixed Nitrogen Research Laboratory,
*Washington, D. C., September 14, 1922.*

Sir: I have the honor to transmit herewith a report of the work of the Fixed Nitrogen Research Laboratory for the fiscal year ended June 30, 1922.

Since this is the first year the laboratory has been under the Department of Agriculture, it appeared desirable to preface the report by a very brief statement as to the establishment and previous work of the laboratory.

The work of the year was completed under the directorship of Dr. Richard C. Tolman, but his resignation and departure for California, coupled with my unfamiliarity as yet with the details of the organization, has necessitated the preparation of this report by those in charge of the various divisions of the laboratory work with very little assistance from me. For editing this combined material into essentially the form in which it now stands, I am indebted to Dr. J. M. Braham, chief of the cyanamide and utilization section.

Respectfully,

F. G. Cottrell,
*Acting Director.*

Hon. H. C. Wallace,
*Secretary of Agriculture.*

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## ESTABLISHMENT OF LABORATORY.

The problem of nitrogen fixation is one of vital national importance, both in war and peace, since nitrogen forms an essential constituent of explosives, of fertilizers, of dyestuffs, and of many other substances used in the arts. The dependence of the United States on foreign sources for its supply of nitrogen compounds, particularly for the manufacture of explosives, was forcibly brought out during the World War, and the danger in such a policy became clearly evident. The demand for explosives was immensely increased upon the entry of the United States into the war. While attempts were made to meet the immediate requirements by importation of nitrates from Chile and by the stimulation of domestic production, principally by-product coke-oven ammonia, the War Department turned to the fixation of atmospheric nitrogen as a means of securing an adequate supply of explosives. Unfortunately, the country was unprepared to solve this problem quickly, due to the lack of the highly technical information and experience required in nitrogen fixation and in the transformation of nitrogen compounds. Although much progress in the relatively new art of nitrogen fixation was made in this country during the latter period of the war, the imperative necessity for further research on nitrogen fixation had been clearly shown.

The Fixed Nitrogen Research Laboratory was established by the Secretary of War on March 29, 1919, for the purpose of continuing the various researches on nitrogen fixation initiated during the war, to obtain further information necessary for the peace-time utilization of the two nitrate plants constructed by the Government at Sheffield and Muscle Shoals, Ala., and to conduct such other investigations as would further the problem of economically producing nitrogen compounds. Authority for this work is contained in the national defense act of June 3, 1916 (subsection "Nitrate plants"), specifically authorizing the President to "cause to be made such investigations as in his judgment are necessary to determine the best, cheapest, and most available means for the production of nitrates and other products for munitions of war, and useful in the manufacture of fertilizer and other products." Funds for the prosecution of the work are obtained from an appropriation made under this act.

On July 1, 1921, the laboratory was transferred by Executive order from the War Department to the United States Department of Agriculture, in view of the fact that nitrogen fixation is largely an agricultural problem in peace times. The laboratory is located at American University, Washington, D. C., making use of buildings and equipment formerly used by the Research Division, Chemical Warfare Service, United States Army. It has a total personnel of 108, exclusive of its consulting staff of chemists and engineers. The authorized expenditure for the fiscal year ended June 30, 1922, was $250,000; the actual expenditure was $241,011.70.

## PREVIOUS WORK OF THE LABORATORY.

The early work of the laboratory was carried out with particular reference to the peace-time utilization of the two Government-owned nitrate plants in Alabama. The cyanamide plant at Muscle Shoals (known as United States nitrate plant No. 2) is the largest cyanamide plant in the world, having a capacity of 220,000 tons of cyanamide or 110,000 tons of ammonium nitrate per annum. This plant operated very successfully in the test run which was made shortly after the signing of the armistice. The principal work, therefore, which the laboratory has carried out in connection with the peace-time utilization of this plant has been to consider what products of fertilizer value could be made there, since it is evident that such a large quantity of fixed nitrogen can be utilized only for agricultural purposes.

The nitrate plant at Sheffield (known as United States nitrate plant No. 1) was designed to operate by the direct synthetic (or Haber) process, with a capacity approximately one-fifth that of the cyanamide plant, or 22,000 tons of ammonium nitrate per annum. The plant in its original form was not a success, however, due in part to insufficient technical information on the various physical-chemical steps which go to make up the process. The laboratory, therefore, undertook investigations to supply such technical information.

In addition to research carried out in connection with these two projects, the laboratory has conducted investigations on other methods of nitrogen fixation, as well as on the transformation and utilization of nitrogen compounds.

The principal results of the investigations made by the laboratory up to the time of its transfer, July 1, 1921, are described in 76 technical reports made to the Chief of Army Ordnance. Some of the material has already been published in scientific and technical journals. In the future it is planned to publish such technical information as will be of interest to the nitrogen industry as a whole. The main accomplishments of the laboratory to November, 1921, are described in a recently published report on the "Fixation and Utilization of Nitrogen" prepared by the nitrate division, Ordnance Office, War Department, assisted by this laboratory.

## WORK OF THE LABORATORY FOR THE FISCAL YEAR ENDED JUNE 30, 1922.

The work of the Fixed Nitrogen Research Laboratory during the fiscal year ended June 30, 1922, has been in part an extension of the investigations already referred to and in part a study of new problems. Seventeen technical reports on the work of the laboratory were prepared during the past year. The main lines of investigation conducted during this period and the more important results are briefly summarized in the following:

### INVESTIGATIONS ON FIXATION PROCESSES.

At the present there are essentially three processes for the fixation of atmospheric nitrogen in commercial operation in various parts of the world. These are known as the direct synthetic ammonia (or Haber) process, the cyanamide process, and the arc process. Several others, such as the alkali cyanide (Bücher), the aluminum nitride (Serpek), and the explosion (Häuser) processes, have also been investigated on a fairly large scale of operation in several countries, but as yet can not be considered as commercially established in the sense of the other three.

In the present state of development of fixation processes in this country, fixed nitrogen can not be produced for fertilizer purposes in competition with Chilean nitrate and with ammonia obtained as a by-product in the coking of coal, except under unusually favorable circumstances. There is every reason to believe, however, that the cost of fixation can be materially reduced through further study and development. During the past year the laboratory has studied the cyanamide, synthetic ammonia, arc, and alkali cyanide processes with that object in view.

## DIRECT SYNTHETIC AMMONIA PROCESS.

The direct synthetic ammonia process is the newest of the three commercially developed processes and is the one which at present apparently offers the greatest opportunity for further development. The laboratory has therefore carried on a large amount of work in connection with it during the past year. In this process a purified mixture of nitrogen and hydrogen is subjected to a very high pressure and passed over a suitable catalyst maintained at about 500° C. Under these conditions nitrogen and hydrogen combine chemically to form ammonia to the extent of from 5 to 15 per cent of the gases present, the percentage depending on the catalyst and operating conditions. The ammonia thus formed is removed and the uncombined gases returned to the apparatus and again treated.

The main features of this process which require further development and on which the laboratory has been engaged during the past year are: The catalyst problem, involving the large-scale production of an active catalyst, the further development of the present catalyst, and the search for new and improved catalysts; the production and purification of the hydrogen-nitrogen mixture; the development of apparatus which will stand the unusually high pressures and temperatures used; and the removal of the synthesized ammonia from the unconverted gas.

The catalyst for effecting the union of nitrogen and hydrogen is in a sense the heart of the direct synthetic ammonia process. The efficiency of the catalyst is in general very greatly reduced by even exceedingly small amounts of impurities in the gas mixture passing through it, hence the necessity of pure gas. The laboratory has continued its studies on the development of a catalyst which will be more active and less affected by impurities than those previously used. The laboratory has developed a satisfactory ammonia catalyst and has perfected a method for its large-scale production. This is a particularly important advance in the development of the synthetic ammonia process. Research on the theory of catalytic action was continued throughout the year, since the art of catalyst manufacture can be placed on a firm scientific basis only through a thorough knowledge of catalytic action.

The production of hydrogen of required purity constitutes the main cost of the entire process, the cost of nitrogen being relatively small. The production and purification of hydrogen from various commercial sources have been studied and improvements in the method of purifying the gas have been made. The laboratory has given special attention to the utilization of waste hydrogen for the synthesis of ammonia. Such waste hydrogen now occurs in connection with the electrolytic manufacture of bleaching materials, caustic alkali, and oxygen. The individual amounts to be considered vary over a range of 20,000 to 100,000 cubic feet per day at the different plants, but the total amount going to waste in America is large enough to be a factor of importance. For the utilization of these relatively small quantities of waste hydrogen, methods of operation quite different from those in large installations must be considered, since some of the economies which can be introduced by large-scale installations are not possible in this case. The laboratory has developed and installed apparatus particularly adapted to the synthesis of ammonia, using waste hydrogen. This equipment has been in continuous operation for several months and important information on the various steps of the process was obtained. This work, when completed, will provide the information necessary for the installation and operation of small ammonia plants throughout the country.

In connection with the engineering features of the process, the construction of a synthetic ammonia plant on a semicommercial scale was begun, so that the numerous mechanical problems involved can be better studied. The plant will also afford a means of testing catalysts under conditions more closely approximating those in commercial operation.

Another problem of great importance and considerable complexity is that of obtaining a material suitable for the construction of the catalyst chambers in which the reaction between nitrogen and hydrogen to form ammonia takes place. Ordinary carbon steel can not be employed, since it rapidly deteriorates, becoming porous and in many cases so brittle that it can be broken with the fingers. To obtain reliable information on this problem, the laboratory has had under test 25 bombs made from different materials. Although the test is still in progress, very important information as to suitable materials for construction of catalyst chambers has already been obtained.

The design and development of apparatus to operate at very much higher pressure than is now regarded as commercially feasible was also undertaken, since ammonia formation is greatly favored by increasing pressure. Although this problem is quite beyond the range of present engineering experience, satisfactory progress was made and important developments along this line are to be expected.

The removal of ammonia from the gas mixture after its passage through the catalyst is a problem of considerable importance in this process. The difficulty lies in removing practically all of the ammonia from the mixture, of which it forms about 5 to 15 per cent, without introducing impurities in the gases which are harmful to the catalyst. The Bureau of Soils, in cooperation with this laboratory, has studied various methods of effecting the removal, and has developed a promising method based on scrubbing the gas under high pressure with a relatively concentrated solution of ammonia, recovering the ammonia thus removed by releasing the pressure on the solution, and liquefying the liberated gas by compression.

The laboratory has published during the past year eight articles in Chemical and Metallurgical Engineering and in the Journal of the American Chemical Society on various phases of the work on the direct synthetic ammonia problem.

### CYANAMIDE PROCESS.

In the cyanamide process of nitrogen fixation, calcium carbide is first produced by fusing a mixture of coke and lime in an electric furnace. The carbide is then powdered, heated to a high temperature, and subjected to the action of nitrogen, usually obtained by fractional distillation of liquid air, with which it combines to form a solid compound, calcium cyanamide. The nitrogen thus fixed can be transformed into a great variety of nitrogen compounds. The process has been in commercial operation much longer than the synthetic ammonia process, and consequently is in a much higher state of development.

The laboratory has made a rather critical study of the present form of the process, from which it appears that improvements leading to a drastic reduction in the cost of operation are rather improbable. The process requires a relatively large amount of electric power for the manufacture of carbide, and hence cheap power is necessary to its profitable operation. Since the manufacture of carbide is now a standardized process, the possibility of materially reducing the power requirements seems somewhat remote. The nitrification of carbide, the second step in the process, is about 85 per cent efficient in the best commercial practice and hence offers some opportunity for improvement. During the past year experimental studies have been undertaken on the fundamental reactions involved in this process for the purpose of determining how improvements might be advantageously made in the present form of the process, as well as to obtain data which may suggest a modification leading to a reduction in cost of operation. Important data on the formation and decomposition of cyanamide have already been obtained, but further study is required to complete the investigation. Researches of this character, as well as those mentioned later in connection with the cyanide process, should throw much light on the reactions of free nitrogen to form cyanamide, cyanides, and nitrides.

### ARC PROCESS.

The arc process is the oldest and, in many respects, the simplest of the three commercially developed methods of nitrogen fixation. It has the very important advantages from a military standpoint that it can be rapidly installed in case of war, and that it provides nitrogen directly in the nitrate form. Since the Government does not own an arc plant, the laboratory has given much less attention to this process, for the time being, than to the other processes. The experimental studies have been confined largely to the fundamental theory of chemical reactions in the path of the electric discharge.

During the past year the laboratory made a rather critical survey of the present form of the process, with a view of ascertaining the nature and extent of the improvements which can be made. The results of this study are given in the "Report on the fixation and utilization of nitrogen." The study showed, in particular, the necessity of improving the method of nitrogen-oxide recovery and of increasing the efficiency of furnace operation. Experimental studies made in connection with nitrogen-oxide recovery are briefly described in a later section of this report. To materially increase the energy efficiency of the process, which at the present time is very low, a more accurate knowledge of the reactions occurring in various types of electric discharge is absolutely essential. In this connection a study was made of the production of ozone by the corona discharge and the production of active nitrogen in the low-pressure arc and in an electrodeless discharge. A number of physical and chemical properties of these two highly interesting and important substances were also determined. Investigations of reactions in the path of electric discharges are continuing, for there is reason to believe that very fundamental improvements may be achieved through such studies.

### CYANIDE PROCESS.

As previously mentioned, the cyanide process of nitrogen fixation has not been successfully developed on a commercial scale. The form of the process developed in this country consists essentially of heating a mixture of soda ash, carbon, and iron to an elevated temperature in the presence of nitrogen gas. The product is a crude cyanide containing 5 to 10 per cent nitrogen which can either be treated to produce a marketable form of cyanide or subjected to the action of steam to produce ammonia. Several important advantages are claimed for the process and much experimental work has been done on it in this country. During the war the Government built a plant for the production of cyanide at Saltville, Va., which was designed to have a capacity of 10 tons of cyanide per day. Although some cyanide was produced, it was shown during the short period of operation that both the chemical and engineering features of the process required further study and development.

The laboratory has made a general survey of this process, the results of which are published in the report on the fixation and utilization of nitrogen. It became evident that two types of research were necessary to its further development—research which would afford a more accurate knowledge of the fundamental reactions involved in sodium cyanide formation, and research on the engineering features of the process, particularly the development of a satisfactory method of manipulating the charge under treatment. The laboratory has been conducting research of the first type. A study was undertaken to determine the influence of such factors as quality and proportions of materials, temperature and duration of treatment, purity of nitrogen, and presence of iron, on the completeness and rate of cyanide formation. The results already obtained indicate that failure to obtain satisfactory conversion to cyanide in the semicommercial tests which have been made in the past was due in part to the low quality of carbon and iron used. Information on the mechanism of the reaction has also been obtained, which suggests ways of improving the process. The work on this process is continuing.

There is some doubt as to whether the cyanide process can be so developed that fertilizer can be produced as cheaply by it as by other processes. It should be pointed out, however, that the development of a process for the production of cyanide, as a final product, directly from atmospheric nitrogen, is very important in view of the increasing demand for nitrogen in the form of cyanides. Until recently their large-scale commercial use was confined essentially to the hydrometallurgy of gold and silver ores, with smaller quantities consumed in casehardening and electroplating, but in recent years the application of hydrocyanic acid as a fumigating agent for fruit trees has opened a new and rapidly growing market of particular interest to this department.

## INVESTIGATIONS ON THE TRANSFORMATION AND UTILIZATION OF NITROGEN COMPOUNDS.

Next in importance to the fixation of nitrogen is the transformation of the different nitrogen-containing substances in order to make them more useful in agriculture, in explosives, and in the arts. During the past year the laboratory has conducted a number of investigations in this connection. Since many of them are described in the report on the fixation and utilization of nitrogen, only the more important ones will be referred to in this report.

### SYNTHESIS OF UREA.

Urea is one of the most attractive nitrogen-containing materials from the fertilizer standpoint, but at the present time its cost for such use is prohibitive. The laboratory has developed on a semitechnical scale a process for the production of urea from ammonia and carbon dioxide which seems to possess possibilities of ultimately yielding this material at fertilizer prices. The process could be very advantageously operated in conjunction with a direct synthetic ammonia plant employing the water-gas reaction for hydrogen, since waste carbon dioxide would in that case be available. The results of the investigation on this process were published in the July, 1922, issue of the Journal of Industrial and Engineering Chemistry.

### OXIDES OF NITROGEN.

Oxides of nitrogen are obtained as the direct product in the arc process of nitrogen fixation, in the conversion of ammonia nitrogen to nitrate nitrogen by oxidation, and also in various nitration processes. At the present time the recovery of oxides of nitrogen from the dilute gas mixtures obtained in all these processes requires very large and expensive absorption systems. Furthermore, the product is a dilute acid, the further concentration of which is also expensive. The importance of developing a process by which the final product can be directly obtained in suitable form, particularly as concentrated nitric acid and dry nitrogen tetroxide, is therefore evident.

The laboratory has made considerable progress in the solution of this problem during the past year. The two main phases of this problem are the separation of the oxides of nitrogen from the accompanying gas and the conversion of the concentrated gases thus obtained into concentrated nitric acid. The utility of silica gel in effecting the separation as well as for the production of dry nitrogen tetroxide has been shown, but further work is required to determine the optimum conditions of operation of this new process. Work was also begun on the direct production of concentrated nitric acid from concentrated oxides of nitrogen. In connection with the possibility of producing concentrated or fuming nitric acid from extremely dilute oxides of nitrogen, so dilute that they are now wasted, a careful study of the reaction between ozone and nitrogen tetroxide was made. It was found that the conversion to nitrogen pentoxide is rapid and quantitative. The present high cost of producing ozone, however, is a limiting factor in commercially applying this process.

### CYANAMIDE.

The direct product of the cyanamide process of nitrogen fixation is calcium cyanamide. From this compound an extremely wide variety of products is obtainable. Thus, in addition to cyanamide, there may be obtained by transformation processes ammonia, nitric acid (by ammonia oxidation), cyanides, hydrocyanic acid, cyanamide, dicyanodiamide, urea, guanylurea, guanidine, etc., and the numerous derivatives of these latter compounds which are becoming important in the manufacture of dyes, drugs, and explosives. Many of these important compounds can not be furnished in quantity by any other process.

The laboratory is making a rather extensive study of the chemistry of cyanamide and its derivatives to open up this new and cheap source of numerous, useful compounds. During the past year methods have been developed for the production of free cyanamide ($H_2CN_2$) in quantity, for the production of urea from cyanamide on a semitechnical scale, and for the preparation of guanidine salts. Cyanamide derivatives which appear to have value as ingredients in explosives have also been studied and the results of the investigations communicated to the ammunition division, Ordnance Office, War Department. In addition, a theoretical investigation on the chemistry of cyanamide was made for the purpose of clarifying the chemistry of this large group of compounds. This investigation is being continued.

### AGRICULTURAL UTILIZATION OF FIXED-NITROGEN COMPOUNDS.

Very little information was available as to the agricultural value of many of the new compounds which are now produced by nitrogen fixation. In view of the possibility of operation of the Government nitrate plants in the then near future, fertilizer experiments were begun at Muscle Shoals and Sheffield, Ala., in 1919, in cooperation with the Bureau of Plant Industry of the department. These experiments were continued by the laboratory to the end of the 1921 season, when they were discontinued. An area of about 20 acres, divided into nearly 500 plots, was used for these experiments, and the following nitrogen materials were tested, chiefly on cotton and corn: Commercial cyanamide, ammonium nitrate, ammonium chloride, ammonium phosphate, ammoniated superphosphate, double salt consisting of ammonium nitrate and ammonium sulphate, chloride mixed salt (made from ammonium nitrate and potassium chloride), sulphate mixed salt (made from ammonium nitrate and potassium sulphate), urea, calcium nitrate, and mixtures of calcium nitrate and cyanamide in various proportions. Sodium nitrate and ammonium sulphate served as standards for comparison. The results of these investigations are now being prepared for publication.

Samples of a number of the above compounds have been prepared for agricultural tests made by the soil fertility investigations section and the tobacco investigations section, Bureau of Plant Industry, at their various experimental fields. In addition, pot experiments have been carried out in cooperation with the soil fertility investigations section to determine the effect on plant growth of numerous other nitrogen compounds, particularly derivatives of cyanamide. Chemical and biological studies have also been made on the transformations of cyanamide in the soil.

In connection with the utilization of commercial cyanamide as a fertilizer, the following investigations were completed during the past year: The stability of cyanamide on storage, the reactions which limit the use of cyanamide in fertilizer mixtures containing acid phosphate, and the possibility of utilizing cyamamide in admixture with calcined phosphate. The results of these studies are now being prepared for publication.

It is evident from the foregoing outline of the work and accomplishments of the laboratory that the field of nitrogen fixation and utilization is an exceedingly large one. Thus, improvement in the existing processes of nitrogen fixation, the investigation of proposed but untried processes, the discovery and development of entirely new processes, and the investigation and transformation of nitrogen compounds to make them most useful, present almost limitless possibilities for fruitful research.

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